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STREET RAILWAY CROWDING in New York city has been made the subject of a report by a special engineering committee organized by the Merchants' Association of New York, and made up of Messrs. H. M. Brinckerhoff, Foster Crowell, C. H. Myers, Geo. A. Soper and S. Whinery, of the American Society of Civil Engineers, with Mr. C. M. Wicker as Chairman. The report affirms that the surface railway lines are not doing all they can to relieve the congestion of traffic. Among the recommendations are the improvement of the crosstown lines, including the adoption of electric motive power upon them, and the abandonment of the storage battery cars on the 54th St. line, the use of an extra conductor on the most crowded cars during the rush hours, and the adoption of proper police regulations to reduce the blockade of cars by trucks.

THE PASSAIC VALLEY SEWERAGE COMMISSION has reported to the New Jersey Legislature in favor of a trunk sewer from just below the Great Falls in Paterson to a point near Robin's Reef light, in New York Bay. There would be two small pumping stations to lift sewage from Bergen and Hudson counties into the main outlet, and a large main pumping station on the Newark Meadows, near the Lehigh Valley Railroad bridge. The total estimated cost of the main sewer and accessories is about $9,000,000, which, the commission recommends, would be divided among twenty municipalities, in proportion to their assessed valuations. This would put about $5,000,000 upon Newark and some $1,500,000 on Paterson. The expense of maintenance would be divided proportionately to the amount of sewage contributed by the various cities and towns. Hering & Fuller, 170 Broadway, New York city, were engineers to the commission.

THE BAY CITIES WATER CO., of California, was incorporated in 1902 to carry out an old project for a new water supply for San Francisco. Mr. Edwin Duryea, Jr., M. Am. Soc. C. E., has been Chief Engineer since December last, and for a number of months past Mr. Frank S. Washburn, M. Am. Soc. C. E., has been consulting engineer. The company controls water rights in Santa Clara Co., and proposes to build the necessary reservoirs, conduits and accessories to develop a large supply of water. Mr. Wm. S. Tevis is President, and Mr. E. G. Wheeler is Secretary of the company.

EXAMINATIONS FOR CIVIL ENGINEERS in the U. S. Navy will be held on Feb. 23, 1903, at the Civil Service Commission rooms, Post Office Building, Chicago, and at the Navy Yard in New York. The rules regulating these examinations will be sent to anyone applying to the Navy Department at Washington, D. C. Briefly stated, candidates must be between the ages of 27 and 35 years; they must be American citizens, have received a degree in the civil engineering course of some reputable professional institution, and have had at least five years' practical experience as a civil engineer and three years' "responsible charge of work." Two, and perhaps three, appointments are to be made in the Corps of Civil Engineers, U. S. N., and it is the desire of the Navy Department that these examinations shall bring out competitors in such numbers and of such character as shall secure a very high grade of men in the Corps. Successful men will rank as junior lieutenants, with $2,700 per year; this is increased to $3,000 after five years' service, and $3,500 after ten years, with retirement on three-quarter pay at the age of 62 years. The work of the Corps is of the most interesting character professionally, and special merit in the service has for its reward Chief of the Bureau of Yards and Docks, with the rank and pay of Rear Admiral in the U. S. Navy.

A VACUUM-TUBE RECTIFIER for alternating currents has been invented by Mr. Peter Cooper Hewitt, of New York City, whose vacuum-tube vapor lamp was first exhibited nearly two years ago. The apparatus is intended for converting polyphase alternating currents into direct current. It is substantially a glass globe having a small cup at the bottom in which is a quantity of mercury; the air is exhausted from this globe to a high vacuum. A number of leads enter the globe at the top, ending in suitable anodes. The various phases of the supply circuit are connected to these leads, and an extra lead is provided for starting the apparatus by direct current. The delivery circuit connects by an electrode with the mercury in the cup at the bottom of the globe. In operation the current from the upper, alternating-current electrodes passes down through the vapor to the mercury and supplies the direct-current line. The peculiar property of the electrodes in this condition is that they will pass current only in one direction, just as in the so-called "electrolytic" rectifier. The direct-current circuit thus receives an impulse from each of the three phases of the alternating-current circuit in turn, and the three impulses superimpose to give a fluctuating direct current. The other side of the direct-current line is connected to the neutral point of the alternator supplying the upper electrodes. The drop of potential between the upper and lower electrodes in the vacuum tube is constant at all loads, about 16 volts, and this drop measures the entire loss in the apparatus, so that the efficiency is very high with high voltages. The apparatus ceases to work when the current falls below a certain critical value, and for this reason the apparatus will not operate on a single-phase circuit; in case of a polyphase circuit the value of the current through the gas never falls below the critical value.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a rear collision on the Central Railroad of New Jersey, near Westfield, N. J., on Jan. 27. A fast express train, west bound from New York city, ran into the rear of a suburban passenger train. At least 15 to 20 persons were killed in the collision and the fire following, and a much larger number were injured. From New York to Bound Brook the railway has four tracks, all protected by automatic electric block signals of the semaphore type. The fast express trains use the inner tracks. The suburban train, which left Jersey City at 5.57 usually takes the outer track, after running a few miles, to permit the through "Royal Blue" express leaving Jersey City at 6.11 to pass it on the inner track. On account of a freight train occupying the outer track, the suburban train received orders to continue on the inner track for some distance farther than usual, and while on this track it was stopped by a hot box. The rear brakeman went back a short distance and is said to have put down torpedoes. The train was getting under way again and the brakeman is said to have just swung on to the rear platform, when the "Royal Blue" express running at high speed crashed into it. The engineer of the latter train (who was fatally injured in the wreck) appears to have ignored the block signals set against him, as well as the warning of a flagman at a highway crossing, who knew that the suburban train was only a short distance ahead and swung his lantern in the endeavor to warn the engineer. The night was dark and the atmosphere heavy. The brakes on the express train are said to have been applied for a minute or so before the collision. Nearly all the casualties occurred in the last two cars of the suburban train. On the express train no one except the engine crew was injured.

A 12-IN GUN WAS DESTROYED in a recent test at the Sandy Hook proving grounds. A shell loaded with 200 lbs. of explosive gelatine was first fired successfully, although more than the ordinary service charge of brown powder was used. But when a still greater amount of brown powder was used in the second charge, the gelatine exploded in the gun, blowing it to fragments. As the firing squad was under cover no one was injured. All that remained of the $40,000 gun were the breech block and the muzzle. The shell used was the invention of Mr. Willard Isham, an engineer who graduated at the University of Vermont, in the early '80's, and who was for some years engaged in railway and many enterprises in Mexico.

A BLACK POWDER EXPLOSION in which four men were fatally injured occurred Jan. 16 at Windbur, Pa. A spark from a pipe is supposed to have set off four kegs of blasting powder.

AN EXPLOSION OF THIRTY BOXES OF DYNAMITE occurred Jan. 10 on the Torresdale filtration plant construction work, near Philadelphia. One man was killed and five were injured. The dynamite (1,500 lbs.) was stored in a magazine having manure-packed walls 2 ft. thick, and a daily paper naively says: "Another precaution against explosion was the heating of the magazine with steam pipes." Just before the explosion occurred the magazine was seen to be on fire, undoubtedly caused by the superheating due to the enclosed steam pipes. The jar of the explosion was felt as far as Vineland, N. J., in one direction and Germantown, Pa., in the opposite direction, 20 miles away. The man killed was pinioned beneath an overturned stove in a house 100 yds. from the magazine. Property damage is estimated at $6,000.

FIN BRAKES FOR A STEAMER are said to have given satisfaction on the Canadian boat "Eureka," 103 ft. long with 12½ ft. draft, 250 tons. Amidships on each side are vertical fins or flaps 3½ × 10 ft. made of ⅜-in. boiler plate. The fins are hinged, and when they swing open are cushioned by water-cushion cylinders, four for each fin. From a 11-knot speed the boat was stopped with great suddenness upon opening the fins and by using one fin was "turned in its own length when going at full speed."

TRACK ELEVATION is again being agitated for in Indianapolis, and the Mayor has appointed a commission of seven leading business men to investigate the subject and make some recommendations as to methods of eliminating the grade crossings. This committee will consult with the City Engineer. The Commercial Club also has a committee investigating the same subject. Over 50 persons are said to have been killed at the various crossings since 1898.

A FOUR-CYLINDER COMPOUND LOCOMOTIVE of the De Glehn type, which is so extensively used on French railways for handling fast and heavy passenger trains, is to be introduced in England by the Great Western Ry. As the loading gage of British railways is smaller than that of continental railways, owing to the narrower limits of tunnels, etc., a special engine is now being built to meet these requirements. The latest De Glehn engines for the Northern Ry., of France, are of the Atlantic type, with inside cylinders driving the front axle, and outside cylinders driving the rear axle.

THE PRESIDENTS OF FOUR AMERICAN ENGINEERING SOCIETIES.

(With inset sheet of portraits.)

We present with this issue, as we have done in previous years at this time, portraits of the Presidents of four American Engineering Societies, with brief biographical notes concerning their professional career.

ALFRED NOBLE.

Mr. Alfred Noble, who has just been elected President of the American Society of Civil Engineers, was born in 1844 at Livonia, Wayne Co., Mich. He was the son of Charles Noble—a farmer by occupation—and Lovina (Douw) Noble, and he received his early education in the country district schools of that section and at the village high school. Some time after the outbreak of the Civil War, or in August, 1862, Alfred Noble, at the age of 18 years, enlisted as a private in the 24th Michigan Infantry, and served continuously in the Army of the Potomac until February, 1865; he was then on post duty until June, 1865, and was finally discharged with the rank of sergeant at the close of the war.

Mr. Noble then obtained a position as a clerk in the War Department at Washington; and while holding this place—from June, 1865, to September, 1867—he prepared himself for admission to the sophomore class of Michigan University. He entered this institution in September, 1867, and was graduated as a civil engineer in June, 1870; though he was absent much of the time during his course, being employed as recorder on the United States Lake Survey, and as clerk and then assistant engineer on river and harbor work on the east side of Lake Michigan.

After his graduation he continued work under the United States Engineer Corps, being engaged on harbor surveys on Lakes Michigan and Huron until October. He was then placed in local charge of the improvement of St. Mary's Falls Canal and St. Mary's River, and continued at this post for twelve years, until August, 1882. It was during this period that the first great masonry lock was built at the Sault. This was at the time of its construction by far the largest canal lock in the world, and its completion and successful operation was a most notable engineering feat.

After the completion of this work, in 1882, Mr. Noble resigned from the government service and went to Louisiana, where, during the fall of 1882, and the winter of 1882-3, he was Resident Engineer on the construction of the Red River Bridge at Shreveport, La., under Mr. G. Bouscaren. In the spring of 1883 he was appointed General Assistant Engineer of the Northern Pacific R. R., of which the late General Adna Anderson was then Chief Engineer. Mr. Noble continued in this position for three years, and had charge of the building of bridges across Snake River, Clark's Fork of the Columbia River and St. Louis Bay, and the foundations and erection of the Marent Gulch viaduct.

In August, 1886, Mr. Noble came to New York, and until July, 1887, he was Resident Engineer on the erection of the Washington steel arch bridge over the Harlem River, under the late W. R. Hutton as Chief Engineer. He then took charge of the erection of the Cairo bridge, over the Ohio River, in 1887-1889, of which Messrs. Morison & Corthell were Chief Engineers, and was also connected with the construction of the great cantilever bridge over the Mississippi at Memphis, under Mr. Geo. S. Morison, as Chief Engineer. This work was in progress from 1888 to 1892. From 1892 to 1894, Mr. Noble was Assistant Chief Engineer, having special charge of the Bellefontaine and Leavenworth bridges over the Mississippi River, and the Alton bridge over the same stream, under Mr. Geo. S. Morison as Chief Engineer.

While Mr. Noble's professional work, above described, had made him well known in engineering circles, he first came into national prominence through his appointment by President Cleveland, in April, 1895, as the civilian member of the first Nicaragua Canal Commission. His associates on this commission were the late Major William Ludlow, Corps of Engineers, U. S. A., representing the army, and Admiral Mordecai T. Endicott, C. E., U. S. N., representing the navy.

This commission was appointed to "ascertain the feasibility, permanence and cost of construction and completion of the Nicaragua Canal" by the route proposed by the Maritime Canal Co. of Nicaragua. At that time the government was on the point of guaranteeing the bonds of that corporation, but through the wise action of a few conservative members of Congress, who counseled delay until an expert investigation of the company's project could be had, the guarantee bill failed and the appointment of the commission, of which Mr. Noble was a member, was ordered instead.

This first Nicaragua Canal Commission was given only a meager sum ($20,000) for its work, and it had only six months in which to make its investigations and prepare its report.

Its conclusions were that, while the high level route proposed by the company was feasible, its adoption was inadvisable until alternative routes had been explored. The Commission also found that the company's estimates of cost were only about half as large as they should be made; and it advised that a new Government Commission should be sent to Nicaragua with funds sufficient to make complete surveys and estimates.

The results of this report were of national importance. It led to the abandonment of the Maritime Canal Company's route, and of the proposal to lend the government's credit to that corporation. It resulted in the appointment of the second Nicaragua Canal Commission of 1897, and later of the Isthmian Canal Commission of 1899, which was given a million dollars and authority to investigate the entire subject of shipment across the Central American isthmus. Of this last Commission, Mr. Noble was also a prominent member, and its final conclusions in favor of the Panama route are too fresh in the public mind to call for repetition here.

Hardly less in importance in public service, we believe, than his work on the Isthmian Canal Commission was Mr. Noble's work as a member of the United States Deep Waterway Commission of 1897. This Commission was appointed by the President to conduct surveys for a waterway from the Great Lakes to tidewater as a result of the agitation for such a transportation route, which was carried on in the states bordering on the Lakes in the early '90's, and which culminated in the report of the first Deep Waterway Commission of 1895-7.

Mr. Noble's associates on the second Deep Waterway Commission were Major Chas. W. Raymond, of the Corps of Engineers, and Mr. Geo. L. Wisner. Their report, presented in 1900, after expending about half a million dollars in surveys, is notable for the selection of a 21-ft. channel as the most economic depth for the waterway, and for the choice of Lake Ontario and the Oswego and Mohawk rivers as its route.

Since his service on the Isthmian Canal Commission, Mr. Noble has been engaged in private practice on a number of important works. Among them we may mention the sea wall at Galveston, Tex., to protect the city from a recurrence of the great flood of 1900, and the bridge across the Mississippi at Thebes, Ill., with which Mr. Noble is associated with Mr. Ralph Modjeski. With Messrs. Chas. W. Raymond, Lt. Col. U. S. Engr. Corps, Gustav Lindenthal, Charles M. Jacobs, William H. Brown and Geo. Gibbs he is associated as members of a board appointed by the Pennsylvania R. R. Co. to investigate and report upon methods of tunnelling under the Hudson and East Rivers in connection with the projected new terminal of the Pennsylvania on Manhattan Island.

Mr. Noble, in 1895, received the honorary degree of LL.D. from Michigan University. He was the President of the Western Society of Engineers in 1898; was made a Junior of the American Society of Civil Engineers on Sept. 2, 1874, and a member April 3, 1878. He is also a member of the Institution of Civil Engineers of Great Britain. He is a member of the University Club and Engineers' Club in New York city and of the Chicago Club of Chicago. Mr. Noble's headquarters for many years were in Chicago; but he is now a resident of New York with offices at 20 West 34th St.

JAMES MAPES DODGE.

Fertility of invention and mechanical ingenuity are rarely coupled with a high order of executive ability, yet such is the combination of qualities that has brought success to Mr. James Mapes Dodge, who was elected President of the American Society of Mechanical Engineers at the annual meeting held in New York city last month.

As an inventor, in a recent report of the Patent Office, Mr. Dodge had the distinction of being mentioned among the few who had been granted over one hundred letters patent, and as an executive he has won success as the President and active managing spirit of two highly successful industrial engineering corporations—the Link-Belt Engineering Co. and the Dodge Coal Storage Co. of Philadelphia—both of which he was instrumental in organizing.

Mr. Dodge was born June 30, 1852, at Waverly, N. J., on the farm of his grandfather, Professor James J. Mapes, a noted chemist and scientist. His mother, Mary Mapes Dodge, has been, since 1873, editor of "St. Nicholas," the well known juvenile magazine published by the Century Co., and is also the author of a number of books. Mr. Dodge spent three years at Cornell University and a year at Rutgers. At the latter institution he took a special course in chemistry under the late Professor Geo. H. Cook, State Geologist of New Jersey. After spending a short time at the Morgan Iron Works in New York city he entered the shops of John Roach, the shipbuilder, at Chester, Pa., where his marked mechanical ability and ingenuity brought him rapid advancement. During the three years at the Chester establishment he was successively journeyman, foreman and superintendent of erection.

Shortly after the Centennial he left the shipyard, and after several years of experience in the East, went to Chicago. It was here that he formed the acquaintance of William D. Ewart, the inventor of the Ewart Link-Belting, and soon after he joined hands with Mr. Ewart and his associates in the development of the chain business.

At that time, about 22 years ago, the application of chains to power transmission was exceedingly limited, and its use in elevating and conveying machinery was practically unknown. The Ewart Chain blazed the way for a new industry, and Mr. Dodge and his associates were quick to seize the opportunity. Mr. Dodge's early work was confined principally to development and manufacture, and here his genius had full play. New chains, new methods of manufacture, and new conveying and elevating appliances were brought out in rapid succession.

After this period of development Mr. Dodge came east and entered the partnership of Burr & Dodge of Philadelphia, for the exploitation of the Ewart Chain and its allied interests. Out of this partnership grew the Link-Belt Engineering Co. in 1888, and after the organization of this company, Mr. Dodge carried out his idea of development along strictly engineering lines. A highly specialized engineering staff was developed, a scientific study was made of the characteristics of the materials to be handled, and special appliances were invented to meet varying conditions.

Machines grew from capacities of 30 tons per hour to capacities of 600 tons per hour, and from simple problems solved by detached machines, the company expanded its field to the planning and arranging of works to secure the most economical and efficient handling of both raw and finished product under guarantees of accomplishment. In all this development Mr. Dodge was the creative and guiding spirit.

It was in 1889, after having become thoroughly acquainted with the needs of the anthracite coal industry, that Mr. Dodge developed the boldest and perhaps the most original of his inventions. This was his system of storing anthracite coal in large conical piles, and reloading it by machinery—accomplishing this result with little labor and practically no breakage. The invention was so complete, and yet withal so simple that after twelve years it is still without a rival in the field of anthracite coal storage.

When it is considered that this system reduced the cost of storing coal from 30 and often 40 cts. per ton per round trip, to 5 cts., the saving effected on the 2,500,000 tons handled by this system annually, has certainly added materially to the good of the anthracite users.

Though for many years a large employer of men, Mr. Dodge has never met with any difficulties on the labor question. He is deeply interested in the personal welfare and advancement of his employees, and the Nicetown shops are a practical example of the philanthropy of self-help.

CHARLES FELTON SCOTT.

Mr. Charles F. Scott, President of the American Institute of Electrical Engineers, was born in Athens County, Ohio, Sept. 19, 1864. His early education was received at the Ohio University in Athens, of which his father, Dr. Wm. H. Scott, was President. When his father was elected to the presidency of the Ohio State University at Columbus, Mr. Scott entered the junior year at the State University and graduated in 1885 with degree of A. B. At Athens Mr. Scott made his acquaintance with the physical sciences under the instruction of Dr. Carl Leo Mees, and at Columbus he continued his work in physics under Dr. T. C. Mendenhall.

Although the facilities afforded for instruction in science, and particularly in electricity, were extremely meager at that time compared with the facilities at present afforded, Mr. Scott attributes the success which he has attained in electrical work very largely to the excellent foundation which he laid under the instruction of the two accomplished teachers whose names have just been mentioned.

Mr. Scott continued at the Ohio State University during the fall of 1885, after his graduation, and in February, 1886, he went to Baltimore. Here his time was divided between the Johns Hopkins University and an apprentice school at the Mt. Clare shops of the Baltimore & Ohio R. R. Evening instruction was given in the various branches to the apprentices and Mr. Scott had charge of the teaching in mathematics and elementary science. At the University he did work in the departments of physics, mathematics and chemistry. The Baltimore & Ohio school was continued a year and a half later, and in the summer of 1887, following the example of some of his friends, Mr. Scott decided to take up electrical work. He found employment with a construction company which was placing an alternating current plant in the Baldwin Locomotive Works at Philadelphia. He was engaged in various parts of the work in the installation of this plant and was also engaged in other electrical work in and about Philadelphia.

In the summer of the following year, 1888, he began work with the Westinghouse Electric Co. in Pittsburg, his first assignment being as assistant to the man in charge of the testing room at night. At that time the machines made by the Westinghouse Co. consisted of four sizes of alternators ranging from 500 to 3,000 lights capacity, together with direct current machines usually used as exciters for the alternators. The alternators were high speed, belt-driven machines with armatures having the wire laid on the surface and held by bands. The largest transformers then made were for 40 lights.

In a few months Mr. Scott was given day work in the testing room and a little later he was transferred to the laboratory which was then under the direction of the late O. B. Shallenberger. Mr. Tesla was at that time in Pittsburg developing induction motors based upon the patents which had been issued to him a few months previous. Mr. Scott was assigned as assistant to Mr. Tesla and devoted a large part of his time to experiments in the development of the motors.

In connection with this work Mr. Scott laid out and had general charge of the preparation and testing of the apparatus for the well known synchronous motor plant which was installed at Telluride, Colo. This was one of the first large applications of alternating current for the transmission of power. The size of the units, 100 KW., and the voltage, which was 3,000, were looked upon as marking quite an advance at that time. Mr. Scott was connected with work upon transformers, measuring instruments and various detail apparatus. He was made Assistant Electrican, and upon the withdrawal of Mr. Shallenberger he was made Electrician. In 1897 he was appointed Chief Electrician, the position which he now holds.

Mr. Scott became widely known to the electrical profession through his announcement, in 1894, of a method of transforming between a three-phase system and a two-phase system by means of two transformers of ordinary type with a special arrangement of connections. He has from time to time read papers before different electrical engineering bodies upon various problems in electrical engineering. During the past year he has been president of the Engineers' Society of Western Pennsylvania, a thriving local engineering society in Pittsburg. The membership in this Society has increased 25% during the year, and the attendance at the monthly meetings has more than doubled.

Mr. Scott assumed the duties of President of the American Institute of Electrical Engineers last September. At that time he read an address in which he presented the important position which the electrical engineer has assumed. This was followed by a statement of what in his mind constitutes the function of the Institute, together with specific plans for the development of the Institute. The position taken is indicated by the following sentences:

It is the function of the American Institute of Electrical Engineers to bring individual workers into a common unity, to join them in a community of interest—a fraternity which is called the electrical engineering profession.

It is the function of the Institute to bring together continually the diversified achievements of many workers, which, taken together, constitute a single total of accomplishment—a total which is called progress.

It is the function of the Institute to take the lead in such measures as will promote the general interests of the profession and the efficiency of electrical work.

The membership should be increased. The power and influence of the Institute is dependent upon the number, character and activity of its members.

Papers and discussion should be contributed from a larger proportion of the membership.

Local meetings of the Institute in various cities will broaden the interest in its work and generally extend its benefits.

Universities and technical schools with electrical departments may organize local meetings of the Institute which would be of benefit to both instructors and students in keeping them in touch with the most recent developments and practice in electrical work.

The collection of engineering data and the establishment of standard practice in electrical engineering is one of the important functions of the Institute.

Permanent quarters for the Institute should be an object of plans and anticipations.

Co-operation with similar institutions in other countries will be mutually beneficial in various ways.

The idea of co-operation has been extended and elaborated by Mr. Scott in his response to the toast, "The Engineer of the Twentieth Century" at the twenty-fifth anniversary banquet of the Engineers' Club of Philadelphia in December. Extracts from his remarks appeared in Engineering News of Dec. 11.

The keynote of that address was co-operation. It proposes that engineers, they who have provided the fundamental requisites which underlie co-operation in industrial and commerical affairs, shall apply to themselves in their own profession the principle of co-operation. This can be carried out by a development of various engineering organizations both national and local, by a general harmony and co-operation between national and local engineering societies and also by the formation of an engineering congress, "a national representative body to stand for the profession of engineering and promote a harmonious co-operation which will strengthen each of the several engineering professions and elevate all." One of the means which he suggests for this broadened scope and greater activity in engineering work is a building common to the uses of the several engineering societies and affiliated organizations.

These references to recent addresses by Mr. Scott indicate the spirit and the policy with which he is directing the work of the American Institute of Electrical Engineers as its President.

C. H. RUST.

At the annual meeting of the American Society of Municipal Improvements, held at Rochester last fall, the office of President was bestowed on Mr. C. H. Rust, City Engineer of Toronto, Ont. Mr. Rust has risen to the position he now holds after a continuous service of nearly 25 years, beginning at the foot of the ladder. Mr. Rust is by birth an Englishman, having been born in the county of Essex on Dec. 25, 1852. His engineering work was begun on the preliminary surveys of the Ontario & Quebec Railway, and his work for the city of Toronto began in 1877 when he was appointed a rodman on the engineering force, under the late Frank Shanly, as City Engineer. In 1881, when Mr. Redmond J. Brough was City Engineer, Mr. Rust was promoted to the position of Assistant Engineer, and two years later he was made Assistant Engineer in charge of sewers. This position he held until 1891, and during this period about 150 miles of sewers were built under his direction, at a cost of $1,750,000. These sewers varied in size from 4½ to 13 ft. in diameter. The first survey and plan for the proposed intercepting sewers at Toronto was made by Mr. Rust and reported on by Messrs. Hering and Gray. The work included a hydrographical survey of a portion of Lake Ontario, in connection with which a number of float experiments were made. From 1887 to 1891 Mr. Rust was Principal Assistant Engineer.

For a few months in the spring of 1892, after the resignation of Mr. Cunningham, Mr. Rust was Acting City Engineer. In July, Mr. E. H. Keating was appointed City Engineer and Mr. Rust was made Deputy City Engineer. In this position he continued until February, 1898, when, on the resignation of Mr. Keating, Mr. Rust was promoted to the City Engineership.

In the winter of 1900 the City Council instructed Mr. Rust to proceed to England to examine into the latest methods of sewage disposal, and upon his return he submitted a report upon the subject to the Council. During the time Mr. Rust has been City Engineer he has also reported upon the cost of a municipal electric light plant, a municipal telephone plant, of obtaining electric energy from Niagara Falls, and upon a system of suburban and interurban railways.

The City Engineer of Toronto has more numerous and varied duties than those entrusted to men in similar positions in many other cities. Thus Mr. Rust has charge of sewers, roadways, sidewalks, bridges and water-works; and street cleaning, street watering and scavenging are also a sub-branch of his department. Under the agreement between the city and the Toronto Railway Co. the City Engineer has to fix the time for the running of the cars; the class of cars used have to be approved of by him, and the routes upon which they shall be run, and various other details, which, of course, occupy a great deal of time and cause no little worry.

In 1887 Mr. Rust was elected a member of the Canadian Society of Civil Engineers, and in 1901 he was one of its vice-presidents. In 1899 he was elected a member of the American Society of Civil Engineers.

A CONVENIENT RULE FOR COMPUTING MAXIMUM REVOLUTIONS FOR FLYWHEELS.*

By Wm. H. Boehm,† M. Am. Soc. M. E.

Methods that shorten the labor of computation are welcomed alike by the busy engineer and the hustling office man. Short cut rules are sought not only to save time, but also to minimize the chances of error.

In a previous issue of this journal, we gave a handy rule for computing the rim speed of flywheels, and we now give a handy rule for computing the maximum allowable number of revolutions for cast-iron wheels of any given diameter.

The rule is based upon the current practice of allowing a rim-speed of one mile per minute for well-made cast-iron wheels, and so does not take into consideration the difference in strength between solid and sectional wheels.

The rule gives very accurately the number of revolutions per minute at which the mile-a-minute danger point is reached. So far as we know the method is new and is as follows:

Rule.—To compute the maximum allowable number of revolutions per minute for cast-iron wheels, when given the diameter of the wheel in feet. *Divide the number* 1,680 *by the diameter.* This is expressed by the following formula:

$$\text{Maximum revolutions per minute} = \frac{1,680}{D}.$$

Example.—What is the maximum allowable number of

*From the "Monthly Bulletin" of the Fidelity & Casualty Co.

†Superintendent Department of Flywheel Insurance, Fidelity & Casualty Co., 97 Cedar St., N. Y. City.

revolutions per minute for a well-made cast-iron wheel 16 ft. in diameter? Here we have

$$\text{Maximum revolutions per minute} = \frac{1,680}{16} = 105.$$

That is a 16-ft. cast-iron wheel should never be run faster than 105 revolutions per minute.

THE SUBSTRUCTURE FOR THE 1,800-FT. CANTILEVER BRIDGE AT QUEBEC, CANADA.

The longest span bridge in the world is now in process of construction across the St. Lawrence River, about seven miles west of Quebec, Canada. This bridge is of the cantilever type and some idea of its enormous dimensions may be had from the following figures: The St. Lawrence River, at the point where the bridge will cross it, is 1,900 ft. wide at low tide and 2,500 ft. wide at extreme high tide, the usual tidal range being 14 ft. and the extreme range reaching 20 ft. The maximum depth of water in the channel is 180 ft., but the river shallows rapidly to a depth of 10 ft. at the river piers at extreme low tide. These river piers are 1,800 ft. apart between centers and the length of the center span is the same figure. The shore spans on each side consist of a 500-ft. anchor arm and a 210-ft. truss span between the anchor pier and the shore abutment. The total length of the structure including abutments is 3,300 ft., and the clear height of the central portion of the main span above extreme high tide is 150 ft. The bridge will carry a double-track railway between the main trusses 62½ ft. apart, and a trolley track and a roadway outside of these trusses on each side of the bridge. The depth of the main trusses at the center is 120 ft. and the height of these trusses above the coping of the main piers is 330 ft., and above high tide is 360 ft.

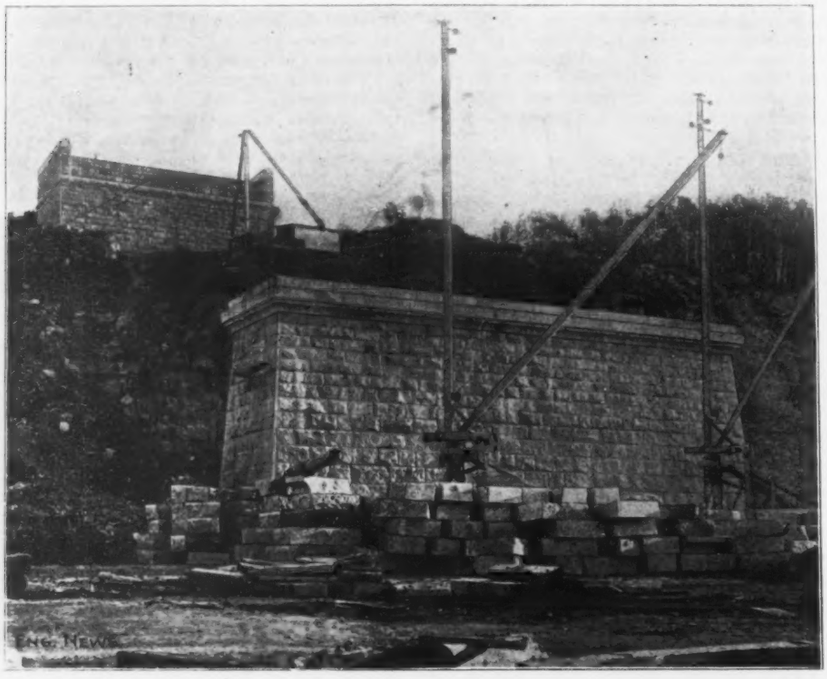


FIG. 1. VIEW OF SOUTH ABUTMENT AND ANCHOR PIER FOR THE QUEBEC BRIDGE.

In considering these figures it will perhaps aid in a full understanding of their significance if we remember that the main spans of the Forth Bridge, in Scotland, hitherto the giant among bridge structures, are 1,710 ft. long, or 90 ft. shorter than the span of the Quebec Bridge. The Forth Bridge, however, has two spans of the great dimension stated, and is exactly 2,030 ft. longer from end to end than its Canadian rival. In a future issue we shall give a full description of the superstructure of the Quebec Bridge and further comparison and discussion will for the present be discontinued. The practical completion of the substructure and foundations, however, makes it possible to describe this work at once, and its description, compiled from information and illustrations furnished by Mr. A. A. Stuart, M. Am. Soc. C. E., Resident Manager for M. P. Davis, Ottawa, Ontario, Contractor for Substructure, follows in the succeeding paragraphs.

ORGANIZATION AND PRELIMINARY WORK.

The construction of a bridge across the St. Lawrence River, at or near Quebec, Canada, has been the object of a number of projects which have been set on foot during the last half century. The first of these projects was inaugurated in 1851. The Quebec Bridge Co., which is the organization now actively engaged in the construction of the great bridge just described, was itself organized as far back as 1887. It, however, formulated no definite plan of action until 1897, when a reorganization of the corporation took place. The present official staff of the reorganized company is as follows: President, Hon. S. N. Parent, Premier of the Province of Quebec and Mayor of the city of Quebec; Secretary-Treasurer, Mr. Ulric Barthe; Chief Engineer, Mr. E. A. Hoare; Consulting Engineer, Mr. Theodore Cooper, M. Am. Soc. C. E.; Engineer in Charge of Masonry, Mr. R. T. Gough; and Engineer in Charge of Instrumental Work, Mr. Alexander Macdougal.

After a careful study of the problem through proper surveys, the company decided upon a definite location of the bridge about seven miles above the city of Quebec. The choice of a site so far distant from the city was necessitated by the great width of the St. Lawrence opposite Quebec and by the unfavorable submarine conditions at that point. To keep the cost of construction within reasonable limits the engineers were compelled to seek better conditions, and these were found about seven miles up-stream, which is at the narrowest point of the river below Montreal. At this point numerous borings were made, which disclosed the fact that, while solid rock was beyond a depth practicable to reach, suitable materials for foundations could be found well within the practicable limits of pneumatic work by locating the main piers near the shores and 1,800 ft. apart.

The topography of the river banks at the site chosen was also particularly favorable to a bridge. The bold promontory which called forth the astonished shout of "Que' Bec" from the early French navigators and gave name to the picturesque fortress city of after times continues to delineate the north bank of the St. Lawrence for many miles by a steep cliff from 150 to 200 ft. high. On the opposite shore the heights of Levis form a similarly abrupt boundary to the river waters. Since the navigation interests required the bridge to be at least 150 ft. above high tide this feature of the topography made it possible to avoid high or long approaches. As has been said, the opposite cliffs came closer together at the bridge site than at any other crossing below Montreal. Owing to this contraction the velocity of the current is from six to seven miles per hour at the height of flood and ebb tide. Furthermore, the large discharge of the river and its widely varying width and depth give rise to a curious and somewhat paradoxical current phenomenon. Flood tide continues to run about one hour after the water ceases to rise, and during the period when it is falling about 18 ins., the water in the center of the stream continues to flow up-stream, while near the shores it runs in the opposite direction. Notwithstanding the great rise of the tide, the water remains fresh at all times to a point 75 miles below Quebec. To return to the main thought, however, it remains to be noted that as soon as the site was selected a contract for the substructure was let in the spring of 1900 to M. P. Davis, of Ottawa, Ont., and for the superstructure to the Phoenix Bridge Co., of Phoenixville, Pa.

GENERAL DESCRIPTION OF SUBSTRUCTURE.

The substructure of the Quebec Bridge consists of three masonry structures on each side of the river as follows: An abutment on the top of the rocky cliff, an anchor pier at the foot of the cliff and 210 ft. from the abutment, and a main pier near the margin of low tide and 500 ft. from the anchor pier. The two main piers, as before stated, are 1,800 ft. apart. A very good idea of the abutment and the anchor pier for the south shore is given by Fig. 1. Those on the north shore were exactly similar in all respects, except the volume of masonry contained. The same statement is true with respect to the main piers. The masonry is granite face work with concrete backing, except the coping courses of the abutments and anchor piers and the upper 19 ft. of the main piers, which are solid granite masonry throughout. The granite was obtained from Riviere a Pierre, 60 miles north of Quebec, and was laid in a one part Portland cement and two parts sand mortar. The facing stones employed were of unusual size, varying from 24 ins. to 48 ins. rise, and averaging about 80 cu. ft. each. They constitute about 30% of the total masonry. All mortar save that used for pointing was composed of one part Portland cement and two parts sand. The concrete was made by mixing in a cubical mixer, as described in a succeeding paragraph, four parts of broken stone with this one cement and two sand mortar.

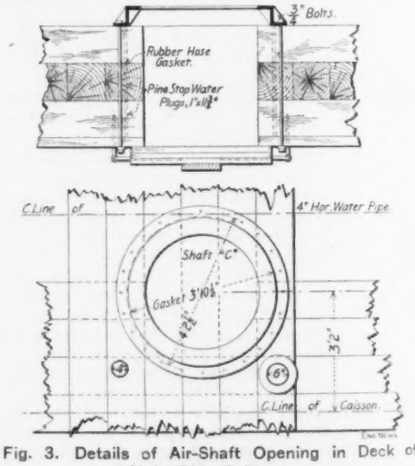


Fig. 3. Details of Air-Shaft Opening in Deck of Main Pier Caissons.

The abutments are U-shaped in plan and measure 80 ft. at right angles to the bridge, the two wing walls each being 40 ft. long. They are founded on solid rock and together contain about 4,000 cu. yds. of masonry. To get solid rock, however, it was necessary to dig through the surface rock, which is of a very irregular and seamy

nature. The anchor piers are rectangular in plan, 22 × 102 ft., under the coping, with the sides battered 1 in. per foot of rise and having a total rise of 65 ft. from foundation to top of coping. Together they contain about 14,500 cu. yds. of masonry and about 500 tons of steel anchorage metal embedded in the masonry. The pier on the north side of the river rests on solid rock commonly called Sillery grit, and the one on the south side rests on a stiff clay, having a depth of about 80 ft., this foundation being 46 × 122 ft. in size. The two main piers together contain about 35,000 cu. yds. of masonry and rest on caissons sunk by the pneumatic process. The coursed masonry begins at the level of the top of the caissons, and below the river bed, its height to the top of the coping being 63 ft. in the north pier and 85 ft. in the south pier.

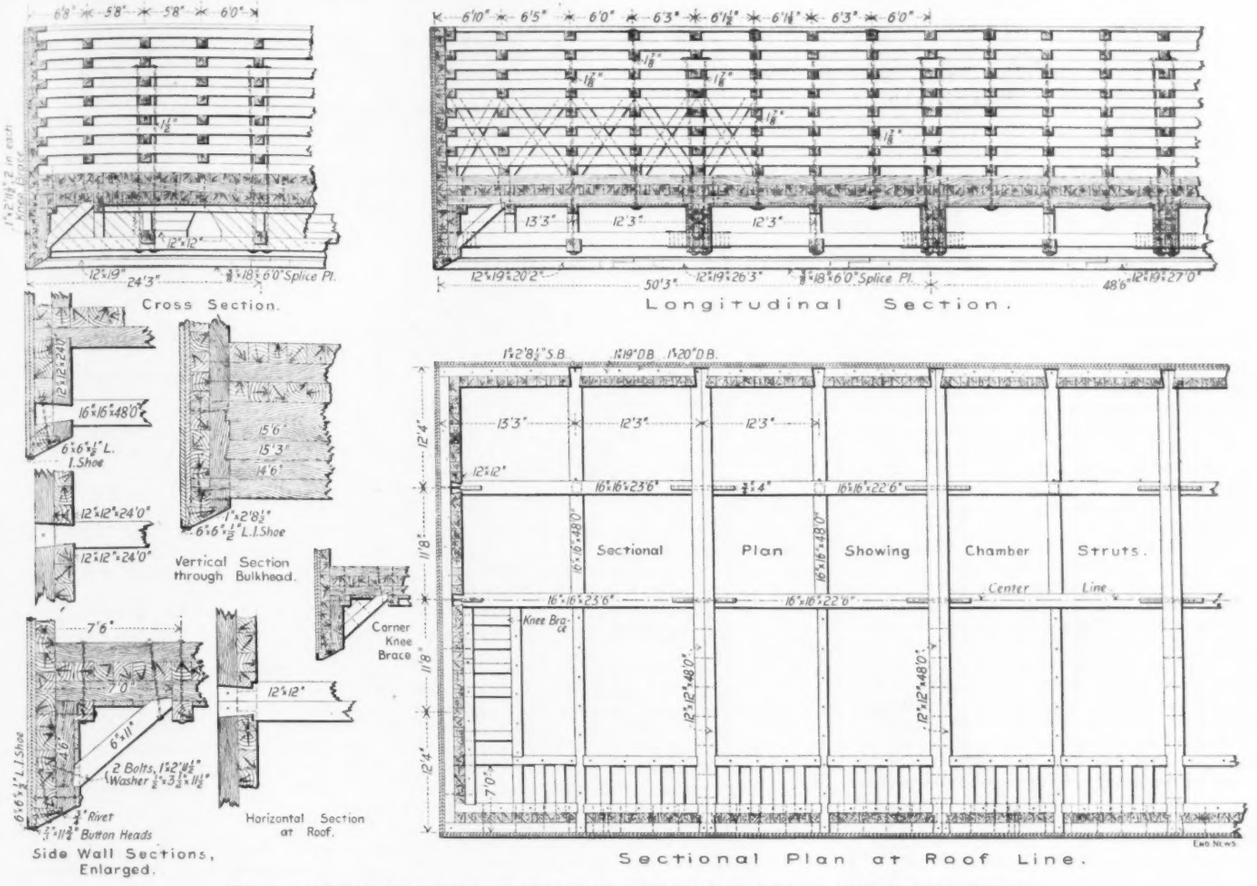


FIG. 2. DETAILS OF TIMBER CAISSON FOR SOUTH MAIN PIER OF THE QUEBEC BRIDGE.

CAISSONS FOR MAIN PIERS.

The most interesting features of the foundation work are the construction, equipment and method of sinking the caissons and the contractor's plant and equipment for performing the construction work of the main piers. Since all these features were the same, except in minor details, for both piers, a description of the south pier work alone is sufficient to explain clearly all the work.

CAISSON CONSTRUCTION.—The caissons for the two main piers were identical in construction and dimensions, and were 49 × 150 ft. in plan and 25 ft. high. Fig. 2 shows the essential details of the caisson for the south pier. The timber used was yellow pine from Georgia, and all main timbers were 12 × 12 ins. in section after dressing. The outside sheathing consisted of two layers of crossed diagonal planking spiked to the sidewalls. A single layer of planking was employed to sheath the ceiling and walls of the working chamber and both sides of the dividing bulkheads. This chamber was 6¼ ft. high in the clear and was divided into six compartments by the transverse bulkheads 2½ ft. thick, just mentioned. The sidewalls at the bottom are beveled at a very flat angle to make a cutting edge 9 ins. wide, which is shod with a ¾-in. × 6-in. × 6-in. steel angle. Generally speaking, the construction of the caissons involves no new features other than the method employed to avoid annoying leaks of water into the shafts due to the wide variation of tide level, and their construction requires no further description than is given in the plans.

The trouble from leakage and the method of remedying it may be described as follows, premising first that the six compartments of the air chamber were each made accessible by means of a material shaft 3 ft. in diameter. It was found that the rising tide would fill the shaft wells with water and that, aided by the leaks of air from the chamber, this water would reach a height somewhat above the river level. No trouble was experienced from the leakage of this water into the shafts until the tide began to fall and the air pressure was correspondingly reduced, when the water in the shaft well escaping less rapidly than it had come in would soon exceed the chamber air pressure, and thus force an entrance into the shafts at the deck line and into the chamber at the ceiling by loosening the oakum in the seams. But for the fact that the air chamber was double-calked with four threads of oakum, this excessive inward pressure would have caused very serious trouble by entirely dislodging the oakum. As an indication of the pressure encountered it may be noted that on one occasion during extreme high tide alarm was given that the roof of the caisson was caving in, when, upon investigation, it was found that this excess water pressure was great enough to draw the ½-in × 7-in. spikes with which the 3-in. lining was spiked to the roof timbers near a shaft, and force several planks downward, giving the appearance of the roof giving away. The leakage mentioned was greatest and most annoying where the shafts passed through the deck, and profiting by the first experience, rubber gaskets in the horizontal seams and stopwaters in the vertical seams were employed around each shaft opening, as shown by Fig. 3. These devices proved to be an effective remedy for the trouble.

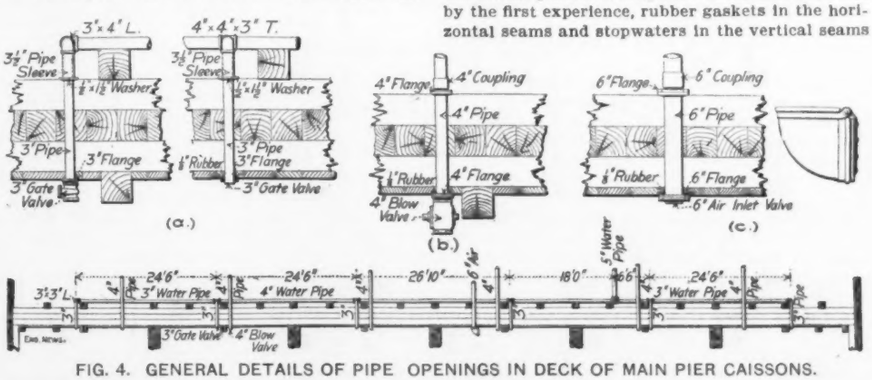


FIG. 4. GENERAL DETAILS OF PIPE OPENINGS IN DECK OF MAIN PIER CAISSONS.

CAISSON EQUIPMENT.—The equipment of the caisson for sinking comprised air and water pipes, material shafts, air locks and accessories. Described in more detail, each compartment of the working chamber was provided with a material

shaft, a blow-out pipe, an air signal pipe and a water pipe. The main air supply pipe entered through the roof of one of the center compartments. The longitudinal sectional elevation, Fig. 4, shows the arrangement of the water and blow-out pipes.

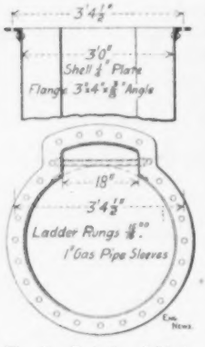


Fig. 5. Details of Material Shafts for Main Pier Caissons.

The six working shafts were built of 8-ft. sections of 36-in. wrought-iron cylinder bolted together with gaskets and outside flanges, and connected to the deck with 24 ¾-in. bolts passing through a special cast deck flange, and the three courses of deck timbers, as shown by Fig. 3. There were two plain shafts used for materials only and four ladder shafts used for both material and workmen. The cross-section of the ladder shafts in each case consisted of 300° of a circular cylinder, and for the remainder of the perimeter of a bent plate offset beyond the circle. The space afforded by this off-set accommodated a ladder, and thus left a 36-in. diameter space clear for the passage of material, as shown by Fig. 5. The two plain shafts were complete cylinders 36 ins. in diameter, and were the only ones provided with material locks.

The two material locks were adapted to work on top of any of the six shafts, but during the process of sinking the caisson were kept on the two plain shafts, and material which would not pass the blow pipes was accumulated at the foot of these shafts by passing it from the adjacent chambers. When sealing the chamber, the locks were transferred from shaft to shaft as each compartment was filled with concrete. A portable platform was built level with the top of each lock and skips filled with concrete were landed thereon and dumped directly into the locks, and when the latter were equalized the charge of concrete would drop through the shaft into the air chamber, where it was shoveled into place and rammed.

The ladder shafts were all converted into man locks by inserting between the sections of the shaft a diaphragm containing a door. Each ladder shaft was provided with two of these and they were raised as new sections of shaft were added. Before using any of these shafts for concreting, the top diaphragm and door was removed and a Moran lock put in its place. The lower of the two diaphragms was made up of two plates, the smaller one containing the door being slightly smaller than the shaft was unbolted from the larger plate and lowered into the air chamber, thus leaving a circular opening 2 ft. 7½ ins. in diameter through which the concrete could readily drop when released from the lock. By the use of these diaphragms it will be seen that man locks of varying capacity could easily and quickly be made. Plans of these two diaphragms are given by Fig. 6. After sealing the chamber, all the shafts were unbolted from the cast-iron Z-bar shoe and lifted out in one piece and the several sections afterwards unbolted, thus preserving the shafts unhurt.

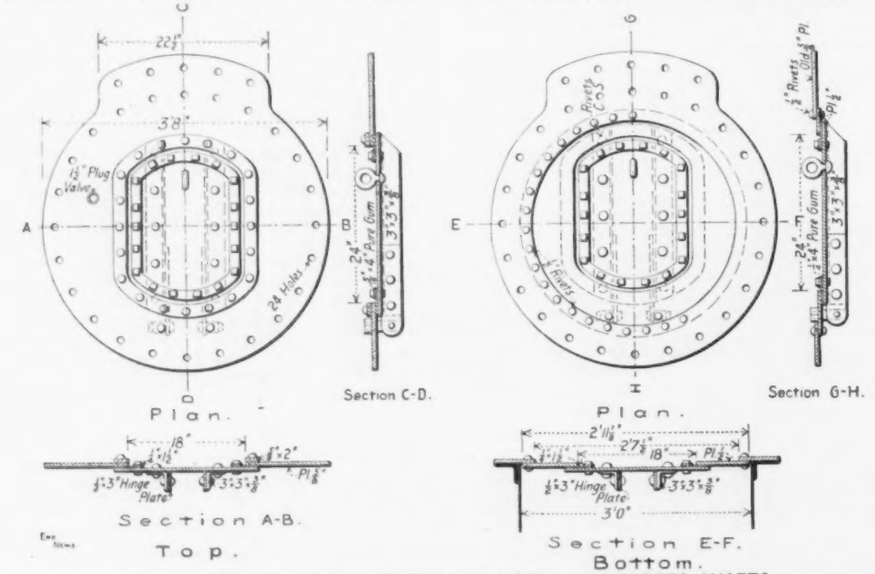


FIG. 6. DETAILS OF DIAPHRAGMS AND DOORS FOR LADDER SHAFTS.

The material locks used were Moran locks and were attached to the tops of the two plain shafts. The construction of one of these locks is shown in detail by Fig. 7. As will be seen, the lock chamber is about 12 ft. long and 5½ ft. in diameter, and is provided with upper and lower doors. The lower door is circular and double-hinged so that it swings entirely clear of the opening. The upper door is made of two halves hinged to links, which work in guides carrying them away from the opening. Both doors close on rubber gaskets and are operated by counterbalanced shafts. To permit the working of the hoisting rope through the upper door when closed a semicircular groove is cut in the closing edge of each half which form a circular hole when the door is closed. A stuffing box carried by the rope closes this hole against the escape of air while allowing the rope to pass freely through it. Fig. 7 shows the construction of this stuffing box, and of all other details of the air locks.

The two locks described were used continuously in sinking the caissons, and proved to be very valuable machines. They were capable of passing iron buckets 34 ins. in diameter and 48 ins. deep, these buckets being filled with excavated material and hoisted directly from the air chamber by a ⅝-in. wire rope operated by a hoisting engine located on the working platform. With the aid of these two locks in passing the concrete to the working chambers, perhaps the quickest work in sealing an air chamber of such size was done in sealing the chamber of the north caisson. The work was begun at 7 a. m., Oct. 31, and continuously prosecuted until 7 a. m., Nov. 6, when the work was completed. During the 144 hours of actual work about 1,500 cu. yds. of concrete were passed into the air chamber, the largest record being 250 cu. yds. in twelve hours of the night of Nov. 3.

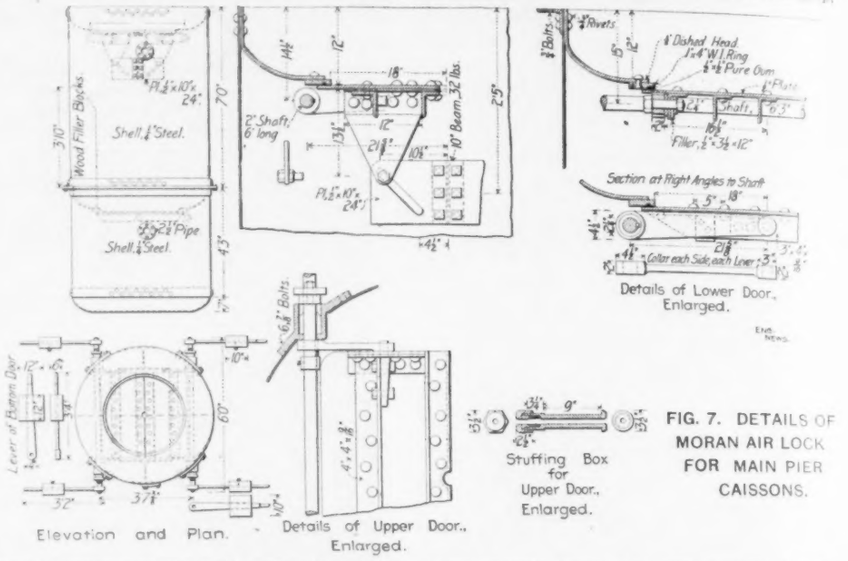

Shell ¼" Steel.
Wood Filler Blocks
2" Shaft, 6' long
10" Beam, 32 lbs.
Shell ¼" Steel.
Details of Lower Door, Enlarged.
Section at Right Angles to Shaft
Lever of Bottom Door
Elevation and Plan.
Details of Upper Door, Enlarged.
Stuffing Box for Upper Door, Enlarged.

FIG. 7. DETAILS OF MORAN AIR LOCK FOR MAIN PIER CAISSONS.

Referring to Fig. 4, it will be seen that a 4-in. water pipe is run along the deck of the caisson near the longitudinal center line, which has six vertical 3-in. pipes extending into the six compartments of the working chamber. There are also six blow-out pipes 4 ins. in diameter, one extending into each compartment. The water pipes having gate valves and the blow-out pipes have special cast-iron plug valves, giving a 4-in. clear way for the passage of mud, sand and small stones. The connections of the water and blow-off pipes to the caisson deck are shown at (a) and (b) in Fig. 4. The air pipe is 6 ins. in diameter. It passes through the caisson deck and terminates in an elbow, the horizontal open end of which is closed by a hinged iron disk faced with leather. The details of this pipe are shown at (c) in Fig. 4.

CONSTRUCTION AND LAUNCHING.—The caissons were constructed on the north bank of the river, at a point about 4,000 ft. below the site of the bridge. They were built ready to sink before launching, and weighed about 1,600 tons each. The launching ways were four in number, each 30 ins. wide and about 300 ft. long, and having an inclination of 1 in. per foot. The running ways were 32 ins. wide and 60 ft. long, and had an effective bearing area of about 550 sq. ft. in the aggregate, thus making a load of about three tons per square foot at the time of launching. Owing to this great pressure some difficulty in launching was apprehended, but by the use of a superior beef tallow thoroughly and freshly applied, the friction was so reduced that the effort down the ways was great enough to split four 12 × 12-in. yellow pine sticks with the grain through a length of 12 ins., and release four 1½-in. screw bolts with which the two end sliding ways were bolted to the fixed ways. The launch was made broadside on, and without accident in case of either caisson.

The north caisson was launched on June 20, 1901, and the south caisson on May 26th, 1902. Prior to launching each caisson a timber working platform having an area of about 12,000 sq. ft. was built on piles around the corresponding pier site. The piles for these platforms were shod, the better to penetrate the boulder formation. Fig. 8 shows the construction of the working platform at the south pier.

SINKING THE CAISSONS.—At the site of the piers the water had a depth of about 10 ft. at low tide and 29 ft. at high tide. As the caissons unloaded drew about 12 ft. of water they grounded at low tide and floated at high tide. The widely varying tidal range occasioned no trouble or inconvenience in handling the caisson while afloat, but when it would barely float at high tide care was required to have it grounded in correct position. Before the next high tide, 12 hours later, sufficient concrete would be added to prevent the caisson from floating again. Therefore as soon as the caissons were in position the work of loading them with concrete was begun and prosecuted continuously until the crib-work above the deck was entirely filled ready to start the pier masonry.

Simultaneously groups of men were put at work in the chamber excavating and removing the boulders constituting the river bed. There were no unusual features in sinking the caissons other than the material to be penetrated, which consisted of sand, gravel and boulders, some of which were many tons in weight, so compacted as to be impervious to compressed air. Due to this latter fact it was possible to keep the excavation below the cutting edges of the caissons as much as 4 ft. without any difficulty, thus greatly facilitating the removal of boulders.

All boulders too large to enter the 34 × 48-in. iron buckets used in removing the excavated material were drilled and broken by dynamite, 3,000 lbs. of this explosive being used in sinking the south caisson, and without a single case of injury from this cause and without the men suffering from the gases evolved. The air chamber was lighted by 16-c.p. incandescent electric lamps, about 100 being used in the six chambers. The current which supplied the lamps was also used to fire the dynamite charges by attaching the leading wires to a lamp socket. When a blast was to be fired the most convenient lamp was unscrewed and the socket attached to the leading wires was inserted and as soon as contact was made the shot was fired. This proved to be quicker, more reliable and more economical than the blasting battery generally used for such purpose.

The sinking of the south caisson was begun on June 7, 1902, and finished on Oct. 17, thus requiring 131 days to sink 59 ft., or at an average sinking of 5.4 ins. per day, varying from a minimum of 2 ins. to a maximum of 10 ins. The number of men employed at the bridge site varied from 500 to 600, and at the quarry at Riviere a Pierre from 100 to 300. The number employed in the air chamber of the south caisson varied from 225 to 300, divided in the beginning into three shifts of eight hours each. This continued until a depth of 50 ft. was reached, when four gangs were employed, working six hours each. When a depth of 65 ft. was reached, six gangs were used, working four hours each, until a depth of 75 ft. was reached, when eight gangs were employed, working three hours each until the final depth of 80 ft. was reached. The maximum air pressure used in sinking the south caisson was 36 lbs., and was endured by the men with little inconvenience and without developing any serious case of "bends."

It is impossible to determine with any exactness the percentage of materials removed through the blow pipes, as no means were used to gage the volume, but it is believed that this percentage did not exceed 10% in the case of the north caisson or 25% in the case of the south caisson. The north caisson was sunk to a depth of 60 ft. below high water, but owing to the existence of a widely extended pocket of sand at this depth on the south shore, the south caisson passes through this sand and to a depth of about 80 ft. below high tide, giving it a penetration of 59 ft. into the boulder formation.

CONTRACTOR'S PLANT.

The plant required and built by the contractor for the prosecution of the work described was unusually elaborate. Briefly described, it consisted of wood-working shops and yard plant for building the caissons; a plant for building the abutment, anchor pier and main pier on each shore, and a quarry plant. The wood-working plant and quarry served the work on both shores, and the construction plant was substantially the same on each shore.

WOOD-WORKING PLANT.—The plant employed in the construction of the caissons consisted of a saw mill and planing mill combined, and was located on the north shore, about 4,000 ft. east of the bridge site, and near the site where the

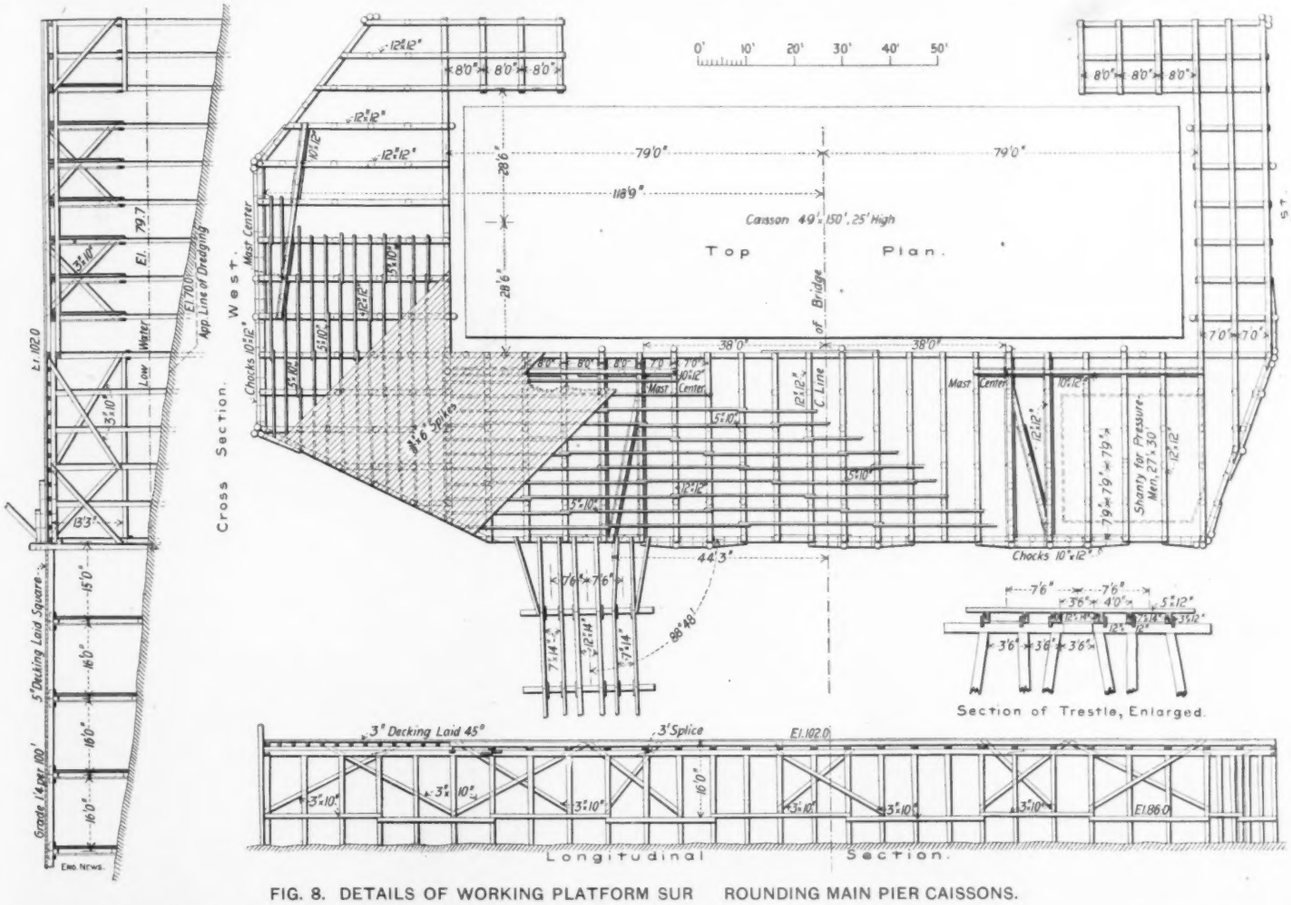


FIG. 8. DETAILS OF WORKING PLATFORM SUR ROUNDING MAIN PIER CAISSONS.

caissons were built on launching ways. This mill was connected with the launching yard by a railway track of 42 ins. gage. In it all the timber was prepared for use in the caissons, temporary buildings, etc. The rough timber entered the mill at the west end and after passing the circular saw was delivered by the carriage to a swinging 36-in. butting saw, where one end was squared, and then passed into the sizing machine which cut four sides at a time, and would take timber up to 12 × 30 ins. After passing into the sizing machine a stop was placed in front of the advancing stick at the proper distance from the butting saw, and when this stop was reached by the forward end, the butting saw was swung into position for squaring the rear end, and at the same time to cut it to the exact length required. The stick was then continued through the sizing machine and loaded onto a car, which delivered it to the two derricks which handled it into position in the caisson. In connection with this mill there was a small machine shop fitted with lathes, planers, drill press, pipe and bolt cutting and threading machine, and an automatic knife

grinder, the whole being driven by a 60-HP. high-speed engine.

SOUTH SHORE PLANT.—The construction plant for building the south shore abutment, anchor pier and main pier is shown in plan and elevation by the diagram, Fig. 9. As will be seen the plant comprised two derricks commanding the abutment, two commanding the anchor pier, five

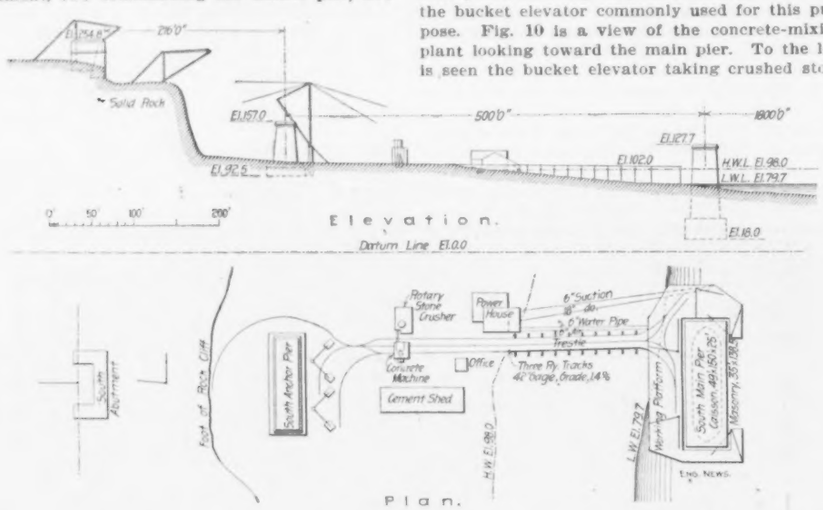


FIG. 9. PLAN AND ELEVATION OF CONTRACTOR'S PLANT FOR SOUTH SHORE ABUTMENT AND PIERS.

commanding the main pier, and of a power house, stone crushing and concrete mixing plant, cement storage house, working platform and a system of material tracks.

The compressed air power plant which supplied all the power for the work, consisted of three duplex compressors, with 16 × 18 × 18-in. cylinders; one 16 × 10 × 10-in. duplex high pressure pump; one 18 × 10 × 12-in. duplex high pressure pump; one 18 × 10 × 10-in. duplex high pressure compound pump; one 10 × 18 × 18-in. single jet condenser; one 10 × 6 × 10-in. duplex boiler feed pump; two 6 × 4 × 6-in. duplex boiler feed pumps; two 7½-KW. electric light generators, and two Moran air locks. This machinery and all the hoisting engines were supplied with steam by a battery of six 100-HP. boilers working under forced draft and supplied with hot water through a feed water heater. The power house and machinery, including the boilers, was set on a heavy concrete foundation. The water supply was taken from the river through one 18-in. suction pipe, a 6-in. pipe also being laid for use in feeding the boilers in event of accident to the 18-in. pipe.

Concrete and mortar for the entire work was mixed in a "Malaxator," or cubical machine, measuring 5 ft. on each side and capable of mixing 2 cu. yds. at a time. It was supplied with crushed stone by a bucket elevator taking the stone from a No. 5 rotary crusher having a maximum capacity of about 30 cu. yds. per hour, and delivering it into a small storage bin, from which it was drawn into the charging hopper as required. The sand and cement were loaded into a rectangular box with a bottom inclined at an angle of about 45°, and hoisted by a small hoisting engine as required, the contents being discharged into the charging hopper along with the crushed stone. The contents of the charging hopper were discharged into the mixer by releasing a lever which controlled the bottom doors. The crusher, stone elevator and mixer were driven by a 50-HP. high-speed engine.

A storage house for about 5,000 barrels of cement was located near the mixer, and a supply of sand was stored near the cement and sand elevator. Two boxes, each with a capacity for one charge of cement and sand, were kept in a pit deep enough to bring their tops flush with the platform, and one box was being filled while the other was being hoisted to the top of the machine, and its contents discharged into the charging hopper. When discharged the empty box was lowered into its pit; the wire hoisting rope was detached therefrom and attached to the filled box, which was then ready to be hoisted. A tongue or guide hinged at the bottom and operated automatically by the boxes was provided to switch the boxes into the four fixed guides, which were centrally located. This arrangement for handling the cement and sand was found to be more reliable, and in every way more satisfactory than the bucket elevator commonly used for this purpose. Fig. 10 is a view of the concrete-mixing plant looking toward the main pier. To the left is seen the bucket elevator taking crushed stone from the crusher to the bin above the mixer; the mixer is located directly above the car carrying the skip; the sand and cement elevator is shown at the right with the pile of stored sand adjacent.

The track system is shown in plan by Fig. 9, and Fig. 10 gives a general view of the whole plant, including the main pier and a portion of the anchor pier. As will be seen, three tracks of 42-in. gage were laid so as to connect the main pier working platform with the various plant on shore, and provided with the necessary cross-over tracks. Due to the facility of movement afforded by these tracks, perhaps, the largest output of concrete ever attained with a cubical machine was attained on several occasions, when 285 charges were handled in ten hours, and on one occasion the machine turned out a batch of concrete every two minutes for a period of five hours, requiring four derricks to dispose of the concrete and handle the empty skips.

All materials for the work on the south side of the river were transported to the working platform at the south main pier on scows and landed at high tide. It was unloaded by derricks and put onto cars or on the working platform. To avoid any possibility of delay to the main pier work a derrick was set at the west end of the working platform to handle all materials required for the south anchor pier or the south abutment. All materials for the main pier were delivered at the south or shore side of the working platform, where two derricks with booms 75 ft. long could readily reach the cargo and put it onto the working platform, which was of ample strength to store 40 carloads of stone. The loaded cars were hauled from the working platform by horses, while those coming from the shore to the platform were brought down by gravity.

NORTH SHORE PLANT.—The construction plant for the north shore abutment and piers was in its general features a duplicate of that described for the south shore work; in fact, the machinery and materials of the north shore plant were largely used in constructing the south shore plant. The crusher plant was set up on the face of the cliff and adjoining the west end of the north anchor pier. The stone was quarried above the top of the stone crusher, and descended to the latter, where it was crushed and dropped into a bin of 25 cu. yds. capacity. From this bin it was drawn through a trap door directly into the measuring hopper. The sand, which was gathered in carts and batteaux from the adjacent beach, was elevated by a bucket conveyor to the mixing platform, there screened by a rotary screen and placed with the cement in the measuring hopper. The charge of cement, sand and crushed stone was chuted from the measuring hopper into the mixer, and thence discharged into the scale boxes of the push cars running on the service tracks beneath. The machinery of the mixer and crusher plant and the arrangement of the service tracks were substantially the same as at the south shore plant. The power plant was also identical.

To get the cut stone to the work it was loaded onto scows at Quebec, where it arrived by railway, and towed up the river to the bridge site. Here the boulder-strewn shore prevented the scows from unloading near the work, so that all stone for the abutment and anchor pier were unloaded at a temporary pier near the caisson ways

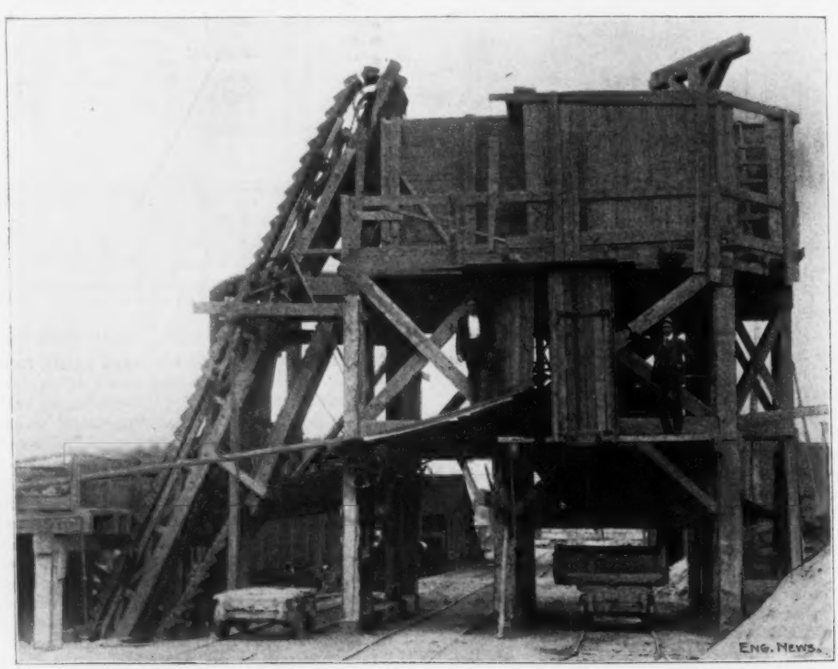


FIG. 10. VIEW OF CONCRETE-MIXING PLANT FOR SOUTH SHORE ABUTMENT AND PIERS.

and taken thence by a double-track railway to the work, 4,000 ft. away. These tracks connected with the service tracks described above. The stone for the main pier could be taken alongside the working platform surrounding the pier at high tide and unloaded onto it.

QUARRY PLANT.—The quarry which furnished all the granite for the work was located near Riviere a Pierre, P. Q., and was opened expressly for this purpose. It is located on the side of a mountain about 125 ft. vertically above the small Riviere a Pierre. A spur track of standard gage construction about one mile long was built to connect the quarry with the main line of the Quebec & Lake St. John Ry. From this spur track two tracks of 42-in. gage were built up the side of the mountain and having a grade of about 25% to reach the cutting yard. At the head of these two tracks and underneath them two large drums were erected on heavy foundations, both being keyed to the same shaft. They were controlled by a friction band operated by a screw and carried 600 ft. of 1-in. steel wire rope each. The stone was placed on small cars and lowered to the foot of the mountain by these drums and there stored ready for shipment, the loaded car during its descent pulling up the empty car.

The plant at the quarry comprised eight large derricks, each with a capacity of 15 tons, three of them being used in the quarrying of stone, three in the cutting yard and two at the foot of the mountain to store the cut stone and load it onto cars. These derricks had masts 18 × 18 ins. × 75 ft. and booms 15 × 15 ins. × 65 ft. There were steam drills, a system of service tracks, forges, small tools and other equipment sufficient to employ 100 stone cutters. The stone was usually shipped in train loads of 12 to 15 cars, and upon arrival at Quebec the cars were run under a large derrick provided for the purpose at Louise Basin, where the stone was transferred to large scows built for the purpose and stiffened with steel trusses. These scows were towed to the work by a powerful tug forming a valuable part of the plant. About one hour would be required to discharge a cargo of stone onto the working platform. In texture this granite is coarse-grained and very similar to the granite used in the New East River Bridge, and works well under the hammer and other tools. It was quarried in large masses of 200 to 1,000 cu. yds., being broken from the solid by the use of black powder. It was then split into such dimensions as required by plug and feather work, the sizes being limited only by the lifting capacity of the derricks.

CONTRACTORS AND ENGINEERS.—The contractor for the substructure of the Quebec Bridge, as has already been stated, was Mr. M. P. Davis, of Ottawa, Ontario, whose staff consisted of Mr. A. A. Stuart, M. Am. Soc. C. E., Resident Manager; Mr. W. L. Scott, Mechanical Engineer; Mr. Henry Barnes, Day Superintendent, and Mr. Charles George, Night Superintendent of Pneumatic Work. Mr. Stuart states that the substructure work will involve a cost in treasure of about $1,200,000, and of human life only one up to this date, the latter being a record without example in a work approaching the same magnitude.

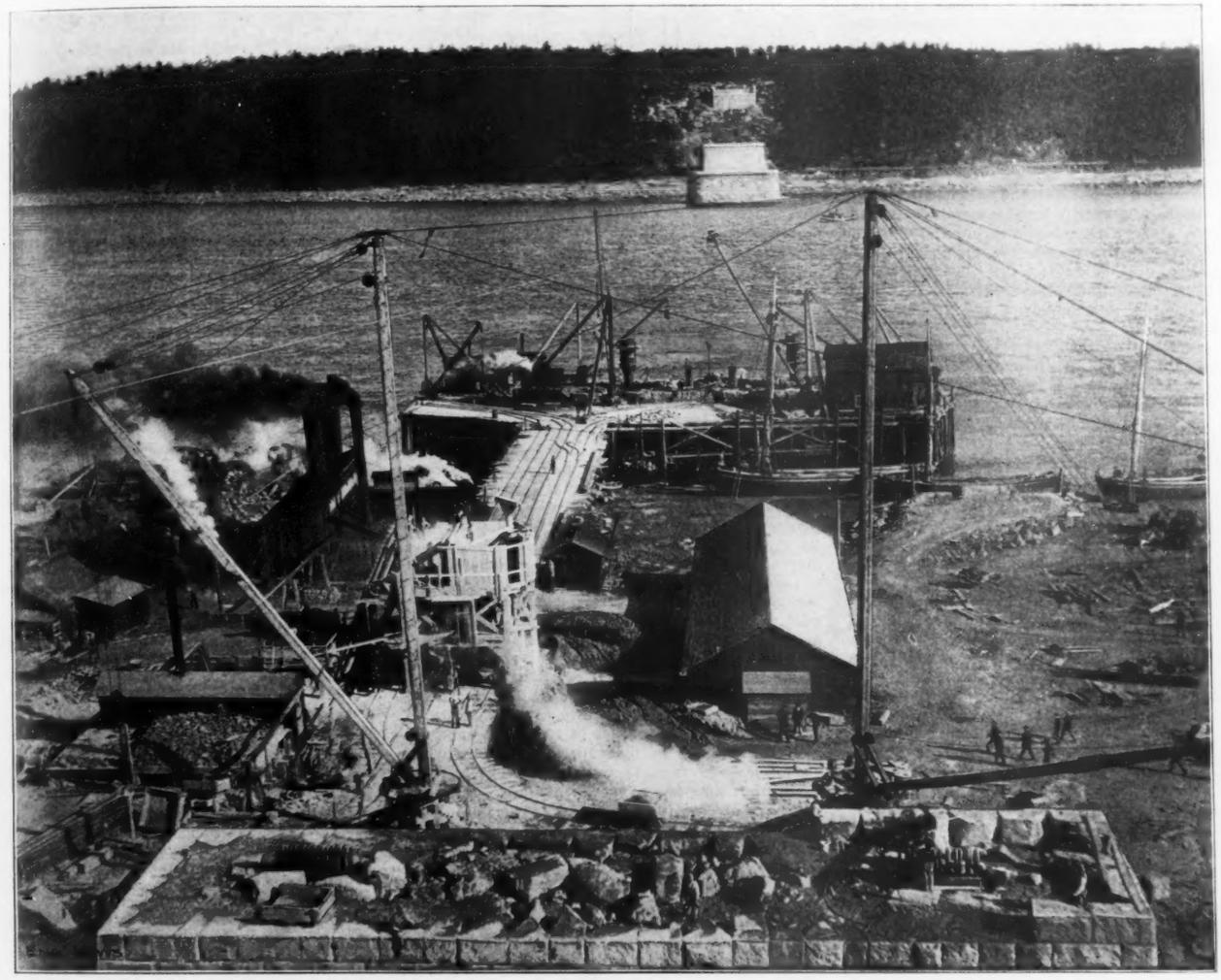


FIG. 11. GENERAL VIEW OF CONTRACTOR'S PLANT FOR SOUTH SHORE ABUTMENT AND PIERS.

ANNUAL MEETING OF THE OHIO SOCIETY OF SURVEYORS AND CIVIL ENGINEERS.

The 24th annual meeting of the Ohio Society of Surveyors and Civil Engineers was held at the Great Southern Hotel, Columbus, on Jan. 20 and 21, 1903. The meeting was called to order by Vice-President Kline with but a small number of members present. The report of the Secretary-Treasurer showed the society to be in good condition financially after all debts and credits are counted. The regular program opened with a paper on "Plans for Sewerage and Sewage Disposal for Mt. Gilead, Ohio," by Mr. J. W. Weddell, of Mansfield. This briefly described the system of sanitary sewers designed for this small village and the accompanying purification works consisting of a settling basin and two intermittent filters of gravel and sand. This was followed by a general discussion on sewage disposal with special reference to its application on Ohio.

The evening session was taken up with a paper on "Concrete-Steel Construction—An Application to Retaining Walls," by Frank A. Bone, of Lebanon. This paper described Mr. Bone's new reinforced retaining wall with the backward projecting foot on which the earth retained rests, increasing the moment against overturning. It was described in Engineering News of March 27, 1902. The advantages claimed were equal security with the older styles and a great reduction of section and cost. The paper brought out a very general and intelligent discussion. Mr. Weddell reported at length upon the advantages of the "Puget Sound District" which he is engaged in developing. President Niederheiser closed the evening

with his annual address, in which he urged increased interest in the work and better attendance.

The program was finished Wednesday morning by a report on instruments, etc., by Mr. J. L. Gilpatrick, of Granville, a paper on "Stream Gaging in Ohio," by Benj. H. Flynn, of Columbus, and a paper on "Surveying a Disputed Line," by Mr. Homer C. White, of Warren. This latter paper was especially interesting to the surveyors and was generally discussed. The paper on stream gaging was merely a review of the work done by the State Board of Health along this line and of the extension of the work which has been undertaken by the Hydrography Division of the United States Geological Survey.

The following officers were elected for the coming year: President, Robert E. Kline, of Dayton; Vice-president, Frank A. Bone, of Lebanon; Secretary-Treasurer, Benj. H. Flynn, of Columbus. Trustees: F. J. Cellarius, of Dayton; A. W. Jones, of Chillicothe; William Evers, of Cleveland; F. L. Niederheiser, of Ashland; I. L. Stinebaugh, of Port Clinton.

It cannot but be admitted that with respect to attendance and general interest the meeting was not a successful one. The quality was all right but the quantity was certainly deficient. Much enthusiasm was shown by the members present however, and better things are hoped for in the future. A special committee on membership and attendance, quickly dubbed the "Boosting" committee, was appointed, whose special work will be the securing of new members and of increasing the attendance.

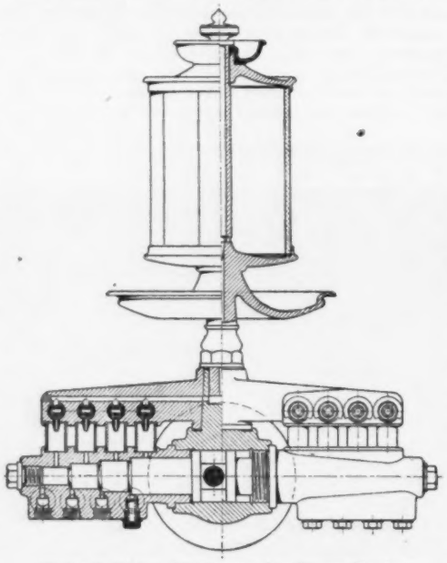
It was felt that the first state society of this class should not fall by the wayside after nearly a quarter of a century of good work. The death of Prof. C. N. Brown had a depressing effect upon the society from which it will be a long time recovering, as he has been the moving spirit of the organization in recent years.

AN UNUSUAL DESIGN OF OIL-PUMP.

European steam engines are, as is well known, quite generally fitted with central oiling systems, in which a central reservoir with pump or gravity supply feeds oil to the various bearings by separate pipes. Sometimes such oiling systems are arranged for pressure supply, to give more efficient lubrication to heavily loaded bearings. A novelty in central oiling systems, which we note in a large steam engine recently built in Germany, is the use of separate pumps for supplying the several oil-pipes. The pumps are combined in a single mechanism in a rather interesting manner.

The engine which this pump supplies is a vertical compound engine of 400 HP. It has three separate oiling systems: (1) The shaft bearings, the crank-pins and the eccentrics are oiled by a lubricator mounted on the cap of each shaft-bearing, which supplies that bearing directly and the adjacent crank-pin and eccentric by oil-pipes. (2) The shaft governor and the attached high-pressure admission eccentrics are oiled by a lubricator mounted on the governor casing. (3) The cylinders, the stuffing boxes, the crosshead guides and the crosshead pins are supplied through oil-pipes fed by a pump. The first two of these oiling systems show nothing unusual; the third is interesting, as already mentioned, by reason of the use of a multiple pump which gives an independent oil supply for each oiling point. Since the high and the low pressure sides require to be separately oiled, the pump must supply oil to eight different points.

A longitudinal section through the cylinders of the pump is shown in the accompanying drawing. There are eight cylinders, having a common axis and arranged symmetrically to two sides of a central point. The diameters of the cylinders in the series of four on each side decrease away from the center. There is a single piston formed in steps, so as to make a plunger-piston for each cylinder; this multiple piston is reciprocated by a crank actuated by the high-pressure exhaust eccentric. Above the battery of cylinders is mounted a supply reservoir, and from here the oil flows into a distributing duct which is separately connected to the inlet ports of the eight cylinders. Between each cylinder and this distributing duct, is a sight-feed glass and a cock, so that the supply can be adjusted to suit the requirements of the particular point lubricated by that cylinder. The delivery ports, on the lower side of the cylinders, are provided with spring check valves to prevent a return of oil from the delivery pipes. It will be evident from the drawing that while the pump does not give a forced supply in case of free delivery of the oil, anything which tends to hinder the flow of the oil in any



Eight Cylinder Oil Pumps for Steam-Engine Lubrication.

of the pipes will cause the pump to produce a corresponding pressure in that pipe. This is utilized in the case of the crosshead in a neat manner: The oil-pipe for oiling the guides runs up through the standards and ends in an opening on the face of the guide. The crosshead shoe is made long enough to always cover this opening, and thus the oil is forced out between the guide and the shoe and is distributed by grooves on the face of the shoe. The oil supply is intended to be sufficient in amount and pressure to float the shoe on a film of oil and thus give minimum friction. The oil-pipe for the crosshead pin, which also runs up through the standard, has an opening on the face of the guide opposite a vertical groove in the shoe; from this groove an oil-passage runs to the bearing of the pin, which thus also has a pressure supply. Suitable oil-guards below the crosshead catch the waste oil and return it to an oil drain.

The oil-pump described above is manufactured by Schaeffer & Budenberg, of Magdeburg, Germany. The engine to which it was fitted in the present instance was a Lentz engine, built by Meer Bros., of München-Gladbach, Germany. The engine is described in the "Zeitschrift des Vereins Deutscher Ingenieure," to whom we are indebted for the cut which we reproduce.

ANNUAL MEETING OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

The fiftieth annual meeting of the American Society of Civil Engineers was held at the Society's House in New York city on Jan. 21 and 22, 1903, with an unusually large and representative attendance. As is usual there was only one session for the transaction of business, the remainder of the time allotted to the meeting being devoted to excursions and social functions. The principal business before the Society was the receipt of the reports of the Board of Direction and of the Secretary and Treasurer, the election and installation of new officers, and the discussion of a proposed amendment to the constitution. The following is an abstract of the report of the Board of Direction:

MEMBERSHIP.—The net increase during the year was 185. In the report of the Board for 1902 statistics of the yearly growth of the Society for 32 years were given, and it was pointed out that the rate of increase for the last few years was apparently not due to temporary conditions. The result of this year seems to emphasize this, the figures of the increase for the past four years being as follows:

1899—Net increase in total membership	103
1900 " " " " "	138
1901 " " " " "	191
1902 " " " " "	185
Total for the past four years	617
Average yearly increase for the past four years	154
Average yearly increase from 1869 to 1898 inclusive	62

The total number of applications received during the year was 362.

Action taken by the Board has been as follows:

Passed to ballot as Members	104
Passed to ballot as Associate Members	140
Elected Associates	14
Elected Juniors	65
Total	323
Applications awaiting action	181

The losses by death reported during the year number 32.

LIBRARY.—The accessions to the library during the year are shown in the following table:

Bound volumes	1,116
Unbound volumes	2,908
Specifications	3,005
Maps, photographs and drawings	357
Total	7,486

In addition to the above, there have been received 489 duplicates and 234 separate numbers to complete files of periodicals, neither of which can appear as accessions.

A comparison with the corresponding figures for last year shows that the growth of the library in 1902 has exceeded that of 1901 (which was regarded as phenomenal) by 1,459 accessions. The library now contains:

Bound volumes	11,330
Unbound volumes	27,909
Specifications	6,658
Maps, photographs and drawings	3,000
Total	47,597

The total number of titles in the library is 19,178. During the year 890 volumes have been bound and 35 bound volumes which were duplicates were received and have replaced previously unbound volumes. The following amounts have been expended upon the library during the year:

Purchase of books, 475 volumes	$1,221.12
Express charges, etc.	99.96
Binding 890 volumes	931.25
Fixtures and supplies	207.29
Total	$2,263.31

The value of the accessions to the library during the year is as follows, each accession having been valued separately, as received:

7,011 donations and exchanges (estimated value)	$2,822.41
475 volumes purchased (cost)	1,224.87
Binding 890 volumes	931.25
	$4,978.53

Owing to the rapid increase of the library and the accession of many new books, by purchase and otherwise, it has been decided to publish a second volume of the classified catalogue, the first volume of which was published in 1900. This volume is now nearly all in type, and it is expected will be issued to all members in about a month.

For the first 45 years of the life of the Society the total number of accessions to the library was 30,847, an average yearly addition of 685 volumes. About the close of 1897 the library was moved into the new house. Since that time the average yearly addition has been 3,350 volumes, the total, as stated above, being now 47,597.

By the terms of the will of the late Herbert Steward, Assoc. Am. Soc. C. E. (who died March 4, 1899), the Society has received, during the year, $1,940, and the Board has accepted this bequest under the terms of Mr. Steward's will, which were as follows:

I give and bequeath to the American Society of Civil Engineers the sum of two thousand dollars, to be known as the Herbert Steward Library Fund. The fund shall be invested and utilized as the Board of Direction of said Society may elect, provided it shall secure a yearly income; which income shall be entirely expended each year for the purchase of books, maps or apparatus suitable for the library of said Society, or for the purpose of promulgating engineering information. I also give to said Society such technical books from my library as may be selected by the Secretary of the Society.

A gift of £10 was also received during the year from Sir Benjamin Baker, Hon. M. Am. Soc. C. E., for library purposes.

PUBLICATIONS.—During the year the usual ten numbers of "Proceedings" have appeared, and three volumes of "Transactions," instead of the usual two, have been published. In the "Proceedings" the list of references to current engineering literature has covered 51 pages, containing 2,614 classified references to 62 periodicals. The demand for publications has been much greater than usual, subscriptions and sales during the year amounting to $3,231.16. The stock of the various publications of the Society, kept on hand for the convenience of members and others, now amounts to 119,850 copies, the actual cost of which to the Society has been $13,904.42. More

than 3,200 volumes of "Transactions" have been bound during the year, for members and others, in the standard half-morocco or cloth bindings. The net cost of publications for 1902 was $6,269.97.

SUMMARY OF PUBLICATIONS FOR 1902.

	Number issued.	Total Edition of each.	Number of pages.	Plates.	Cuts.
Transactions*	3	{2,800 / 2,900 / 3,100}	1,434	52	327
Proceedings*	10	3,000	1,266	40	141
Constitution and List of Members	1	3,200	237	..	..
Advertisements ...	10	3,000	108	..	..
Totals		....	3,045	92	468

*Includes Indexes and Tables of Contents.

Since publications were begun by the Society, 31 years ago, there have been published 49 volumes of "Transactions," 28 volumes of "Proceedings" and 33 miscellaneous separate publications, consisting of indexes, catalogues, lists of members, etc. The total number of pages in these publications has been 42,099, an average yearly output of 1,358 pages.

Beginning with 1896, the system of publication was changed, and since that time "Proceedings" and "Transactions" have been issued separately.

For the 24 years, 1872-1895 (inclusive), there were issued 22,799 pages, a yearly average of 950 pages, and for the past seven years the total issue has been 19,300 pages, an average of 2,757 pages per year.

MEETINGS.—During the year 25 meetings have been held, as follows: At the annual meeting, 2; at the annual convention, 6; regular semi-monthly meetings, 17. At these meetings there were presented 18 formal papers, 4 of which were illustrated with lantern slides; 7 topics for informal discussion, one of which was illustrated with lantern slides; and 8 illustrated lectures. The Thirty-fourth Annual Convention was held at the Willard Hotel, Washington, D. C. There were registered at this convention 343 members of the Society, in all grades, accompanied by 377 members of their families, and other guests. This was the most largely attended convention of the Society ever held.

FINANCES.—An examination of the Secretary's statement of receipts and disbursements, and of the general balance sheet which accompanies it, will show the financial condition of the Society. During the year the sum of $1,940 has been received from the executors of the estate of the late Herbert Steward, Assoc. Am. Soc. C. E., this sum to be invested and the yearly proceeds to be used in the purchase of books, maps, or apparatus suitable for the library, or for the purpose of promulgating engineering information.

When, in 1895, the project for building a new house was under consideration, the total assets of the Society (omitting the estimated value of the library, and of publications in stock) were about $65,000. Making no allowance for increase in the value of the present property since it was purchased, the total assets are now about $167,000.

In the report of the Board for the year 1898 it is stated that "the permanent loan has been fixed at $85,000, which loan has been secured at a rate of 4¼%." The payment, on January 15, 1903, of $10,000 on the principal of the mortgage, which has been authorized by the Board, will reduce the debt to $55,000, which is now carried at 4% interest. In other words, $30,000 has been paid off in four years.

The report of the Secretary showed receipts of $62,497.85 and expenditures of $52,193.77.

The committee on rail sections reported progress and asked to be continued. The report of the committee on uniform tests of cement was then read and ordered printed. This report is published in full in another column of this issue. The question of amending the clauses of the constitution relating to the election of members was then taken up for consideration. The special committee reported an amendment whose substance was to give the Board of Direction power to classify applicants for membership as to grade, but which left the election as at present in the hands of the general membership. Mr. John F. O'Rourke offered a substitute amendment which called for the election of members by the Board of Direction, affirmative votes of all but three members of the Board being required for election. The discussion on this amendment was very heated and finally resulted in its rejection by a vote of 88 against 68.

MUNICIPAL ELECTRIC LIGHT AND POWER PLANT AT RICHMOND, IND.*

By James B. Nelson.†

The city of Richmond, with a population of 18,226 in 1900, is one of the most substantial and wealthy cities of its size in Indiana. The present mayor, Dr. Zimmerman, was elected in 1898 on a platform advocating municipal ownership of the water-works and electric lighting plants, both at that time under the control of private corporations. A contract had been entered into with the Richmond Light, Heat & Power Co. for lighting the streets for ten years from July 1, 1894, the city agreeing to use not less than 150 arc lights of 2,000 c. p. at $90 per year. About 180 lights were used. As the company owned the gas works as well as the electric light plant, it encouraged the use of gas for commercial and domestic purposes and made no effort to extend the electric lighting service. Under a provision in this company's franchise (which runs 25 years from 1894), it might have been required to make extensions under certain conditions, but the price permitted (under the franchise) to be charged for incandescent lighting was so high that practically the extension of the service was in the control of the company. This more than anything else fostered a sentiment in favor of a municipal plant, and on Aug. 6, 1900, the council ordered plans and specifications to be prepared.

I recommended the installation of multiphase generating apparatus, and as it was believed that the plant would eventually have a considerable motor load, three-phase generators were selected. Thus it is possible to use the same dynamos for operating arc and incandescent lamps in series for street lighting, multiple arc and incandescent lamps for commercial lighting, and motors for power. Construction was commenced in June, 1901, but owing to delays in getting the engines in running condition, the plant was not completed and accepted until July 26, 1902.

The power station has two generating units, with space for a third unit. The larger unit consists of a 650-HP. cross-compound engine, directly connected to a 450-KW. generator; the smaller unit consists of a 450-HP. engine and a 300-KW. generator. Both units operate at a speed of 150 revolutions per minute, the generators being arranged to run singly or in multiple, as desired. The generators are of the General Electric Co.'s three-phase, 60-cycle, 2,300-volt, revolving-field type, with a guaranteed efficiency at full load of 93½%. The engines were built by the Alfree Engine Co., of Indianapolis, and are designed for 150 lbs. steam pressure, and to run condensing. The original specifications called for a speed of 125 revolutions, as it was not believed that engines of this type could be operated at a higher speed. But it was afterwards ascertained that the Alfree company would agree to guarantee engines equipped with its new expansion valve gear to work successfully at 150 revolutions.

The difficulties sometimes encountered in the operation of direct-connected alternators in parallel are greatly reduced by increase in speed, and incidentally the increase effected a material saving in the cost of generators. The parallel operation of alternating-current generators presents one of the most exacting requirements with which the engine builder has to contend. The builders of the generators demanded that the regulation of the engines should be such that the angular variation during one revolution should not exceed one-tenth of one angular degree when the load is varied between the limits of zero and full load. The engine governors were also required to be so adjusted as to preserve as closely as possible equal and simultaneous crank movements during load variations. The engines might have been made tandem-compound at less expense, but it was believed that there would be less oscillation with the cross-compound system, giving four instead of two impulses at each revolution.

For exciting the fields of the generators there are two 15-KW., 125-volt, direct-current generators, each driven at 400 revolutions by a direct-connected Alfree center crank engine with cylinder 7 × 8 ins. The exhaust-pipe is so arranged that these engines may be run condensing. There is a duplicate system of cylinder lubrication: 1. A large tank holding several gallons is connected to the four engines by pipes; 2, a small steam-pump forces it to the cylinders. The bearings are oiled by gravity from a 2-gallon tank, which is kept full by a small rotary-pump driven by a belt on the engine shaft. The oil dripping from the bearings is returned through pipes to a filtering tank, to which the pump suction is connected.

The specifications provided for three 100-light 6.6-ampere constant-current "tub" transformers, for operating the series arc street lamps, but two of these were omitted until after the additional lamps are needed. The transformer installed has a small switchboard panel of its own. The main switchboard has six panels. Two three-phase recording wattmeters register the output of each generator.

There are two jet condensers which can be operated together or either one in connection with either engine. A Crane back-pressure valve is mounted over each condenser to discharge exhaust steam to the atmosphere in case of failure of the vacuum. There are two duplex plunger boiler feed pumps. Also two duplex light service pumps for pumping water from the hot-well or from the receiving well near the power house direct into the heater; these pumps are equipped with Fisher governors. The pumps and condensers were all furnished by the Stilwell-Bierce & Smith-Vaile Co., and are placed in a pit 16 ft. deep in the engine room. There is a Cochrane combined feed-water heater and purifier, in connection with which is used the Sorge chemical purifying system.

In the boiler room are three Sterling water-tube boilers of 310 HP., with space for a fourth. Each boiler has 3,100 sq. ft. of heating surface, and the grates are fed by Roney mechanical stokers. The boiler pressure is 150 lbs. The 8-in. steam pipes from the boilers connect with a 12-in. leader, and each engine has a vertical steam separator, with automatic trap, next to the throttle valve. A longitudinal separator, with trap, is placed in the receiver pipe between the high and low-pressure cylinders.

For testing the plant an original and interesting method was adopted, consisting in the use of the Whitewater River, 100 yds. distant, as a water rheostat. Two poles were set up on one side and a third pole on the other side, connected by two wire cables across the river. Each cable carried a movable trolley, from which was suspended a metal plate submerged in the river, each plate being connected by an insulated copper wire with a separate phase of the generator. A third plate was suspended near the third pole at the intersection of the two cables, and this was connected with the remaining phase of the generator. The two movable plates were moved to any desired position, both being kept at the same distance from the third plate, which was stationary. This scheme was devised by Mr. Gard, the superintendent, and gave entire satisfaction. Each unit was in turn operated to its rated capacity for several hours, and also to considerable overload.

For street lighting there are 255 arc lamps arranged in series in four circuits, the maximum and minimum in any one circuit being 75 and 55 respectively. In the former circuit are also 14 incandescent lamps of 100 c. p. for lighting a small park. For commercial and domestic service the city was divided into six districts, there being four feeder circuits leading to four centers of distribution, and one feeder circuit having a primary and secondary center of distribution. No services are taken off the feeders, primary mains radiating from the centers of distribution. There are 14 transformers of 15-KW. capacity, having 2,000 volts on the primary side and 115 volts on the secondary side, each transformer having its system of three-wire secondary mains. These are in the closely built-up sections of the city, and other smaller transformers will be erected as required. The feeder circuits are all three-phase, as are the primary mains where there is probability of a motor load and when necessary to distribute the load. The primary mains for lighting in residence districts are run single phase, care being taken to keep the load balanced as nearly as possible between the three phases. The four series arc circuits for street lighting require about 40 miles (12 tons) of wire; the commercial circuits require 70 miles (30 tons). At present 74 street lights are being furnished by

*Abstract of a paper read at the annual meeting of the Indiana Engineering Society, at Indianapolis, Jan. 15.

†City Engineer of Indianapolis, and Consulting Engineer for the city of Richmond, Ind.

the city's plant, and the balance of the company under its contract; this condition must continue to prevail for nearly two years.

The coal bins are loaded by a chute from a trestle, and can hold 30 to 35 carloads. Perforated pipes connected with the pumps and with the city mains are run into the bins so as to flood the coal in case of fire. At a height of 10 ft. above the boiler room floor is a platform with steel chutes to the hoppers of the stokers. When the coal in the bins reaches this elevation it can readily be shoveled into the chutes. No conveyor system is used. The building is of brick and stone, with a steel chimney 125 ft. high and 12 ft. diameter, lined with brick throughout. Near the power house a brick-lined well is sunk into the gravel, to a depth of 7 ft. below low water level of the river. From this an intake line of 24-in. sewer pipe runs to the river. This well supplies the condensers.

The contract for the plant complete was let to the Varney Construction Co., of Indianapolis, for the lump sum of $144,490. The highest bid was $161,450, and the engineer's estimate was $152,790.

At the beginning of 1903 the plant supplied 82 street arc lights (some of these furnished by the railways), 274 commercial arc lamps and about 9,000 incandescent lamps. Very little power has been furnished. Meter measurement is used. The following are the rates: 1 to 50 KW., per month, 9 cts.; 50 to 200, 8 cts.; 200 to 1,000, 7 cts.; 1,000 KW. or over, 6 cts.; minimum charge per month, 50 cts. A discount of 20% is given for payment before the 10th of the month. I do not favor these rates, as there is too much difference between the cost to the small and the large consumer, and the discount is too great. I recommended a rate of 8 cts. per KW., with a discount of 7½% on all bills under $10, and 15% discount on all bills over $10, paid before the tenth of the month. This was adopted, but afterwards changed. It would have given a minimum possible net rate of 6.8 cts., which is low enough even for a municipal plant. The gross earnings for December were $2,711; in this the city is charged with 74 street lights at $75 per year, this plan of charging the city a fixed price being adopted in order to place the plant on a business basis. Under a state law the operation of the plant is in the hands of a commission appointed by the city council, which is better than placing the construction and operation in the hands of the council itself.

ANNUAL CONVENTION OF THE ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS.

The 18th annual meeting of the Society was held at Aurora, Ill., Jan. 21, 22 and 23, the meetings being held in the council room of the City Hall, and the headquarters being at the Hotel Bishop.

At the opening session, on the afternoon of Jan. 21, an address of welcome was delivered by the mayor, Mr. G. W. Alschuler, which was responded to by the Vice-President, Mr. E. E. R. Tratman (Associate Editor of Engineering News). The annual address was then delivered by the President, Mr. H. G. Paddock, City Engineer of Moline. The address touched on several points of current interest: the proposed co-operation of the State with the U. S. Geological Survey in the preparation of a topographical map of Illinois; the need for better roads and road legislation; the possibility of building good dirt roads; and also the near approach of completion of the Hennepin Canal, upon the results of which will depend the future of many other projected waterways.

LAND SURVEYING.

The Committee on Surveying presented a report which dealt particularly with the need for greater completeness and accuracy in "plats" or plans of surveys, and in the descriptions and marking of the property. This report was presented by Mr. W. M. Hay. In the discussion, Mr. L. Z. Jones advocated the use of two monuments and a base line instead of simply a single monument as a starting point. Mr. Clark advised a still greater number of monuments, and Mr. Orwig (C. & N. W. Ry.) outlined the requirements of the Michigan law, which were noted in our report of the convention of the Indiana Engineering Society last week. Mr. Paddock thought that most of the trouble came from resurveys, and surveyors are therefore more careful now than they used to be. The discussion was then directed to the question of the advisability of requiring owners of property in cities and towns, who are about to build, to furnish a plan of survey, together with the building plans, to the official or department which has to approve the building plans. It seemed the general opinion that this would be advisable, although there was some difference of opinion as to the methods to be followed. At a later meeting a resolution was adopted expressing the opinion that plans should be accompanied by proper descriptions, and permanent monuments set.

A paper on "The Real Estate Records of a Great Railway System" was then read by Mr. H. I. Orwig, Assistant Engineer in the Land Department of the Chicago & Northwestern Ry. An abstract of this is given elsewhere in this issue.

DUTIES OF THE CONSULTING ENGINEER TO THE ILLINOIS RAILROAD COMMISSION.

This paper was by Mr. F. G. Ewald, the Consulting Engineer to the Commission, and it gave rise to some discussion as to the protection of grade crossings of steam roads with electric roads. Mr. E. E. R. Tratman pointed out that some electric interurban roads are operating cars or trains at half-hour intervals at speeds of 40 to 50 miles an hour. Another member stated that a street railway near Chicago (operated under a steam railway franchise), crossed by the Aurora, Elgin & Chicago Electric Ry., tried to compel the latter to build an overhead crossing, and compromised on an agreement for the A. E. & C. Ry. to stop all cars at the crossing, so that the other road might benefit by a transfer of traffic. This crossing is not protected by interlocking, since all cars stop. At a subsequent meeting a resolution suggested by Mr. Melluish (of Bloomington) was adopted, recommending an amendment to the law under which the Railroad Commission would be given power to enforce the elimination of existing or prospective grade crossings of either steam or electric roads. The cost of eliminating the grade crossings by separating the grades to be apportioned between the railway company, the State, and the town, or city. An abstract of Mr. Ewald's paper is given below:

The act of 1871 creating the Railroad and Warehouse Commission requires it not only to examine into the business operations of railroads, but also requires it to make an inspection of the physical condition of the property. Inspection trips are made annually, it being the aim of the commission to cover about half of the mileage of the state each year. On these trips the consulting engineer is required to observe the condition of all track, and the character of its material; the condition of all bridges, stations and buildings; to note also whether all frogs and switches have been properly blocked; to note the clearance of all overhead and side obstructions; to note the character and condition of right-of-way fence; to note the condition of the right of way with respect to cleanliness and combustible materials; and to note also the condition of all farm crossings, approaches to highway and street crossings, and crossing signs.

The time usually consumed in making an inspection of each road varies from one to six days, depending on the character of the road and the number of miles to be covered. As the inspection progresses, notes are kept which are used later as a basis for a report to the commission and published in the annual report. For the lack of time and assistants these inspection trips are usually of a superficial nature, but experience gained in connection with the department of maintenance of way enables the engineer to observe the existing conditions very closely. He is also required to investigate all accidents on railways. His numerous other duties forbid the investigation of all accidents, but the more serious ones are looked after as soon as he may become advised. The results of these investigations are also submitted to the commission in the form of a report, but are not published.

The act of May 27, 1889, provides that any railway company desiring to cross the main tracks of another railway company, shall construct the crossing at such place and in such a manner as will not unnecessarily impede or endanger the traffic upon the railway so crossed. In case of objections to the crossing, either party may apply to the Railroad and Warehouse Commission, whose duty it shall be to view the site, hear evidence, and give a decision prescribing the place and manner in which such crossing shall be made. The consulting engineer is required to accompany the commission in viewing the site of the proposed crossing, in order that he may prepare any plans, submit estimates, or furnish an opinion concerning any engineering features.

The act of June 2, 1891, provides that any company whose main tracks are crossed by the main tracks of another company, and which desires the crossing to be protected with interlocking, may petition the Railroad and Warehouse Commission for an order to provide such crossing with a complete system of signals and safety appliances. A plan showing the location of the tracks involved must accompany the petition. All railway companies are duly notified, and a time set for viewing said crossing, after which the case comes up for hearing before the commission and a decision is rendered. If the commission shall have cause to believe that any such grade crossing is dangerous to the public or to trains, it may cite the several railways forming such crossing, to show cause why such crossing should not be provided with the necessary safety devices.

In either case, the consulting engineer is called upon to accompany the commission in viewing such crossings. After the commission has finally promulgated its opinion concerning the installation of any interlocking device, the railway companies submit plans of the proposed interlocking system, with switches and signals, and the system must receive approval before the work of construction is begun. If, in the opinion of the consulting engineer, the plans do not conform to the requirements of the commission, the character of traffic passing over each road is taken into consideration with respect to location of derails and signals, and the plans are accordingly amended and the construction of the interlocking system must conform to the plans thus approved.

The commission assumes no authority over interlocking systems other than those located at crossings, junctions, and drawbridges; and no such system can be placed in operation until the same has been duly inspected by the consulting engineer, after receiving due notice that the same is ready for inspection. Following the inspection of the interlocking device and acceptance of same, a complete report of the inspection is made to the commission with the usual recommendations that a permit be issued, allowing trains to run such crossing without stopping. The permit provides, however, that the enginemen must have their trains under control in passing through the interlocking limits. All railway companies are also required to file monthly reports concerning the condition of each interlocking system in which they are interested, and the number and character of all derailments that may have occurred during the preceding month. A record of such derailments is kept in the office, compiled and published in the annual report.

The work of compiling statistics from the regular annual reports submitted by railway companies was formerly done by the secretary, but of late years it has gradually devolved upon the consulting engineer to do so. The work above outlined not only covers the operations of steam roads, but includes the operation of electric interurban roads which are incorporated under the general railway laws of the state.

FARM DRAINAGE.

This paper was read by Mr. L. Z. Jones, and had been prepared mainly for the advice and instruction of farmers, but it was received with very general interest, and was followed by some discussion as to the respective rights of owners of adjacent property, in regard to drainage works. The paper outlined the general principles to be observed in the preparation of drainage projects, and describes also the practical work, the tools used, etc. One point made was that the drains do not stop work when they have sufficiently drained the land, and means were suggested for preventing the carrying off of subsoil water by such drains.

At the morning meeting on Jan. 22, the first proceeding was the presentation of the

REPORT OF THE RAILWAY COMMITTEE.

This dealt with the construction of new lines and the improvement of existing lines. These improvements include such work as double tracking, new and stronger bridges, etc., and also such work as extensive new construction for cut-offs and diversions to improve grades and curvature in order to effect greater facilities and economies in operation. The question of interurban electric railways, and their grade crossings with steam railways was also considered, together with the importance of records of itemized details of cost of work. The report concluded with remarks upon railway location surveys.

SURVEY OF ILLINOIS.

Mr. W. H. Herron, of the U. S. Geological Survey (Topographical Department), then read a paper on "The Proposed Co-operative Survey of Illinois," which survey is to be made by the Geological Survey in co-operation with the State

of Illinois, and a bill providing for this is now before the State Legislature. The paper pointed out the importance of the survey, and of the maps which would be made, the work being done according to the standard practice of the government survey.

WORK TRAIN METHODS AND RECORDS.

This was a very brief paper, by Mr. L. P. Atwood, Engineer of Maintenance of Way, on the Rio Grande, Sierra Madre & Pacific Ry. (Mexico), describing the methods of work in making embankments, and showing the way on which records are kept of the work and its cost. We print the paper elsewhere in this issue.

THE TESTING LABORATORY OF THE CHICAGO, BURLINGTON & QUINCY R. R.

An address describing the laboratory and test department, which is located at Aurora, was delivered by Mr. M. H. Wickhorst, Engineer of Tests, and in the afternoon Mr. Wickhorst took the party through the shops and laboratory, and also showed the test car or dynamometer car, which was described in full in our columns some months ago. At the laboratory, tests are made of the quality of all supplies and materials purchased, and of the steam and fuel economy of boilers, etc. The water supplies for water stations are examined and analyzed, and the company has three water-softening plants at work, which are under the direction of the testing department.

THE AURORA, ELGIN & CHICAGO THIRD-RAIL ELECTRIC RAILWAY.

This paper was by Mr. E. E. R. Tratman (Engineering News), and described the construction, equipment, power plant and operation of this 56-mile high-speed electric railway. The line was described in our issue of Oct. 9, 1902.

WATER-WORKS AND PUBLIC IMPROVEMENTS.

The report of the Committee on Water-works was then read by Mr. J. W. Alvord (Chicago), but the discussion drifted to the general subject of the defects in the present public improvement laws of the State. The discussion was lengthy and animated, covering not only water supply, but sewers and paving. Mr. Paddock (Moline), thought that all ordinances for bond issues should provide for a sinking fund to redeem the bonds. The following is an abstract of the committee report upon water-works:

Undoubtedly new water supply construction in the State of Illinois is at a low ebb owing to the continuance of unfavorable legislation. But few new works have been built of recent years, and it is increasingly difficult to finance new propositions, as bankers and bond buyers will not consider securities of this class in this state under the present circumstances. Many small cities of the state would be exceedingly glad to install supplies and pay for them liberally if it were possible to do so in any legal manner. As a consequence of these conditions, water supply engineering in this state is confined to the remodeling and extension of works already built and the improvement in the purity of present sources of supply by means of filtration. Large improvements of this kind are being constructed at Moline and Danville and many smaller places are considering the matter.

In water purification much thought and study is now being given to the preliminary processes which must be adopted to remove sediment and turbidity and prepare the water so that it may be properly passed through the filters without undue clogging or washing. Sedimentation has long been the favorite method of accomplishing this result, but other processes are coming to the front for the same purpose. The city of Philadelphia, after two years of careful experimental work, has reached the conclusion that turbidity may be removed and the ordinary rates of flow through slow sand filters may be doubled by the use of so-called preliminary filters, and has just let a contract for an installation costing $90,000 at the lower Roxborough station. These preliminary filters will consist of 11 tanks, 16 × 24 ft., and 5 ft. deep, each containing a coarse material averaging ⅝-in. in diameter superimposed upon a layer of broken stone in which is laid the entrance pipe corresponding to the under drains of an ordinary filter. The filter is operated with the inflow from below and the turbid waters are deprived of their suspended matter by mechanical adhesion to the particles of the filter. In order that the upward flow may be uniform, a mattress of sponge 8 ins. thick is held compressed uniformly over the top surface of the filter through which the flow must finally pass.

The experimental tanks have shown that with raw Schuylkill water 70% of the turbidity and 90% of the bacteria have been removed with a cost for wash water of 40 cts. per 1,000,000 gallons, and a labor cost of 30 cts. per 1,000,000 gallons. The slag of which the body of the filter is composed has to be washed once a day by reversal of flow, the outlets for this purpose being made seven times the area of the inlets. The sponge mattress requires removal and washing four times a year. The Schuylkill water has a maximum turbidity higher than the Ohio, although its average is not equal to that of the latter stream. Such preliminary filters are operated at rates of 60,000,000 to 80,000,000 gallons per acre per day without chemicals of any description. Approximately 1-in. to 12-in. head is used in passing the flow through the filters. In Philadelphia they expect to largely increase the rate of flow through the final filters as a result of this preliminary work.

The large portion of the water supplies of Illinois are derived from artesian sources, and it has become increasingly difficult for many of the larger cities in the northern part of the state to obtain a sufficient quantity of this water for domestic purposes. Many ingenious plans have been devised for increasing the flow of such wells, such as at the Rockford plant.* Recently the writer has been engaged in designing a new form of rotary pump for a large railway company near Chicago, in order that it may develop a supply of 5,000,000 gallons daily from artesian wells. The lift will be nearly 200 ft., and it is proposed to lower the pumps directly into the artesian wells and drive them by means of shafts directly connected to horizontal electric motors at the surface. A trial installation has been constructed at the company's works and preliminary tests give assurance that the obvious difficulties can be overcome and good efficiencies obtained. Development along this line promises a good field of activity.

In conclusion, your committee would note the widening field in rotative machinery for pumping purposes generally. The high efficiencies which have been recently obtained for centrifugal pumps compounded and in tandem are worthy of mention, while positive displacement pumps of rotative type are already successfully on the market.

A large amount of engineering work is to be done in the future in establishing the purity of water supplies, and much earnest and careful study is being given to the elimination of water-borne pollution as a menace to the public health.

At the evening session several subjects were briefly discussed. Mr. L. Z. Jones referred to the raising of grade on embankments on the Chicago, Burlington & Quincy Ry., in which bad slips occurred along the upper edge of the new and higher bank. Prof. Talbot described tests of breaking strength of concrete of various proportions for street foundations, and several members spoke of making concrete successfully in freezing weather, though it was universally admitted that this should not be done if it could be avoided. Mr. J. W. Alvord and Prof. Talbot referred to the lack of precise knowledge of the efficiency of centrifugal pumps. As to septic tanks, Mr. B. J. Ashley (Chicago), thought it best to admit storm water. Mr. Alvord was inclined to the same opinion, but Prof. Talbot held the opposite view.

THE ABSORPTION TEST OF PAVING BRICK.

The general conclusions of the paper by Prof. A. N. Talbot (University of Illinois), were as follows:

For the grades of brick tested, the absorption test reliably determines the softer and less burned grades, and is useful when the average porosity for well-burned brick is known. The absorption tests have no value in determining overburned brick, no change in porosity evidently taking place after the point of proper vitrification is reached. Brick with a coarse fiber will have a different absorption rate from a fine grained brick, and the process of annealing may affect the degree of porosity.

The closing session was called to order about 9 a. m., Jan. 23, when Prof. Talbot read a second paper on

THE GROWTH OF ENGINEERING EDUCATION.

The paper pointed out that the great increase in the number of students at engineering schools is an example of the growth of industrial education, and its effects upon the material prosperity of the country. This growth in numbers of students at different institutions was shown by a diagram, which is reproduced herewith. The number of engineering students was about 3,000 in 1888-89, 9,600 in 1898-99, and 16,600 in 1901-02. This latter number was divided among 115 institutions, and the majority were in 30 of these institutions. In certain respects, especially as to practical work, American engineering schools are ahead of these in Europe.

A large equipment and great variety of apparatus is now required for the numerous general and special subjects of instruction and investigation. At Cornell University and at the Massachusetts Institute of Technology, the engineering equipment (exclusive of buildings) is valued at about $500,000. The increase in equipment is partly duplication to provide for additional numbers of students, but it is also largely for work along new lines of investigation. The advantages of engineering schools to industrial enterprises, by reason of their facilities for investigation work, are not yet fully appreciated in this country.

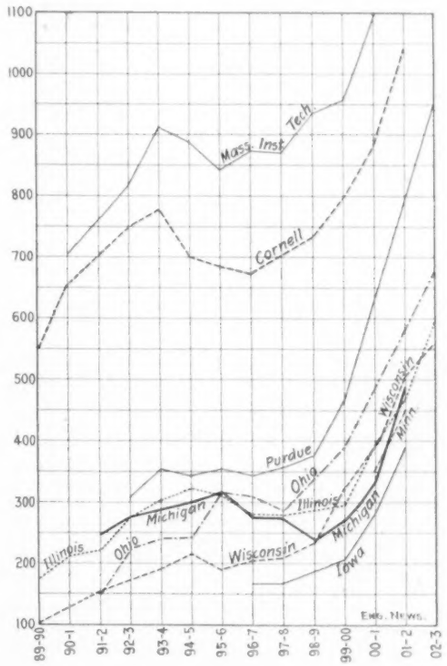


Diagram of Attendance at Engineering Schools.

(Number includes regular and special undergraduate engineering students.)

A brief paper on "Drainage Ditches," by Mr. P. C. Knight, was then presented. Resolutions were passed expressing the thanks of the Society to Mr. Hallett, Consulting Engineer, Mr. Stolp, the City Engineer, and other local hosts for courtesies shown and entertainment provided.

EXCURSIONS.

On Thursday afternoon, Jan. 22, a special train provided by the Chicago, Burlington & Quincy R. R., took the party to the water-works plant, under the guidance of Mr. W. D. Hallett, consuling engineer for the works. In the pumping station are two Dean pumps, a Nordberg triple expansion engine, and an air compressor built by the American Well Works for the Chapman air-lift system. The water supply is obtained from four deep wells, and delivered to a new reservoir of 1,500,000 gallons capacity, which was built last year and described in Engineering News of May 22, 1902. From this reservoir the water is pumped to a stand-pipe. The party then visited the plant and new machine shop of the American Well Works, being conducted through the shops by the President, Mr. M. T. Chapman. From there the party proceeded to the shops of the Chicago, Burlington & Quincy R. R., where Mr. M. H. Wickhorst, Engineer of Tests, took them in charge for a trip through the engine, machine, boiler and car shops, and the testing laboratory, and finally to the dynamometer car. (See Eng. News, vol. July-December, 1902, p. 388.)

OFFICERS AND PLACE OF MEETING.

The election of officers resulted as follows: President, John W. Alvord, Consulting Engineer, Chicago; Vice-President, John C. Quade, Engineer for Western Tube Co., Kewanee, Ill.; Secretary and Treasurer, E. E. R. Tratman, Resident Editor of Engineering News, Chicago. The next meeting will be held at Champaign, Ill., in January, 1904, by special invitation of the University of Illinois.

*Described in Engineering News some time ago.

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ADVERTISING RATES: 20 cents a line. "Want" and "For Sale" notices, special rates, see page XXIV-XXIX. New copy for standing advertisements should be received one week in advance of publication; new advertisements, Monday morning. The pages containing "Want," "For Sale" and "Proposal" advertisements are held open until Wednesday noon.

The signing of the treaty with Colombia on Jan. 22, giving to the United States a concession for the construction of the Panama Canal, is a noteworthy step toward the beginning of actual work—that is to say, it will be if the Senate on the one hand and the Colombian legislative body on the other, sees fit to ratify the instrument. That such ratification will take place now seems probable, although it is quite likely that opposition may appear in both cases.

The principal provisions of the treaty are a payment by the United States of $10,000,000 down and an annual rental of $250,000 per year, beginning nine years hence. For this payment the United States is to receive the desired privileges for the construction of a canal, with limited jurisdiction over a 10-kilometer strip of land along it. The details of jurisdiction, as set forth in the treaty, are rather intricate. In drafting the instrument it was necessary to give the United States the authority to control and safeguard the canal, and the commerce through it, as well as the forces employed in building and operating it. On the other hand, it was also necessary to leave "sovereignty" over the strip in the hands of Colombia, since the government of that country, by its Constitution, may not cede its sovereignty over any part of its territory. The result is that the terms of the treaty will probably be a disappointment to those who proposed to virtually convert a slice across the Republic of Colombia into United States territory, and Senators who held this point of view may very likely oppose the ratification of the treaty.

It appears to us, however, after study of the treaty's provisions, that it gives to the United States all the rights and privileges necessary for the construction and operation of the canal. We pay a very stiff price for them, it is true—$10,000,000 down and an annuity of $250,000, which is equal to interest at 2% on $12,500,000. Thus the total payments to the Colombian Government may be taken as amounting to $22,500,000 capital, and in addition the United States must pay for the land and water rights which it may require for the construction of the canal and auxiliary works. To this is to be added the $40,000,000 payment to the Panama Canal Co., and the engineers' estimate of the construction costs of $144,233,000, making the total cost of a canal by the Panama route over $200,000,000. It is noteworthy that this is over $10,000,000 more than the estimate for the cost of constructing a canal by the Nicaragua route. Against this apparent advantage of Nicaragua, however, must be set the cost of obtaining the necessary concessions from Nicaragua and Costa Rica, and the additional cost of maintenance and operation at Nicaragua of $1,300,000 per annum. If we reduce this to capital on the basis we assumed for the proposed annual rental to Colombia, we have the large sum of $65,000,000. We do not see, therefore, that the Nicaragua route offers any financial advantages over Panama; and the only question for the Senate to decide is whether it will pay the price asked by Colombia and let the work of construction proceed.

A fatal accident from electric circuits, noted in another column of this issue, calls renewed attention to the importance of properly safeguarding electric wiring and fitting work. An ordinary lighting circuit, of only 205 volts potential, supplying the Fulham public baths in London, caused the death of two bathers a few weeks ago. It was testified that the voltage at the point where the victims made contact was 165 volts. Voltages as high as this and even higher are in common use in the interior circuits of buildings. The general public and even persons practically familiar with electrical work have grown to consider such circuits as harmless. High potential wires are given much attention by electricians, against both fire hazard and danger to life, and the non-electrical public has a wholesome fear of such circuits; but circuits at only the ordinary incandescent lighting voltages receive little attention from electricians, and are not at all feared by the users of electric current.

It seems to us that the accident at Fulham may well be a lesson to those responsible for the safe installation of interior wiring. The circumstances under which the victims at Fulham took a relatively large amount of current: the wet condition of such a bath cabinet, and the firm contact made by grasping the capping bar with wet hands, are unusual, of course. But this is a question of degree, and a serious accident might occur under many less unusual conditions. The safe rule for the electrical fitter to follow should be like that of the railway signaling engineer, whose signals turn to danger when anything about them becomes deranged; any accident to the wiring should affect the system itself (in the present case blow the fuses) before it creates danger to life or danger of fire. We place danger to life first; but it must be confessed that regard for conditions creating a fire hazard is uppermost in governing the specifications for electric house installations, and the danger to persons is thought of only as a secondary matter. In the Fulham installation, the system was considered satisfactory, as was testified at the inquest, because it was safe against danger of fire. The contingency which actually came to pass had not seemed to occur to any one. Even in this country, with an excellent National Electrical Code (which, by the way, was drawn up for the National Board of Fire Underwriters), there is need to pay more attention to the danger of injury to persons through defective electric circuits.

We may allude in this connection to the fact, with which all electrical engineers are more or less familiar, that in all systems of house lighting from alternating currents where current is taken from transformers, there is always a chance that current may leak across directly from the primary to the secondary, and thus the full potential of 1,000 to 2,000 volts of alternating current may be brought upon the interior wiring of a house. Many severe shocks and fatal accidents have been due to this cause. A partial safeguard against such accidents is to avoid placing any lighting fixtures where they can be touched by a person at the same time that he is in contact with any grounded metal work, such as plumbing or gas fixtures, radiators, hot-air registers, etc. This precaution would not be effective, however, in basements or other rooms not having dry wooden floors. For such places the best precaution is an effective grounding of fixtures, conduits, etc., likely to be charged with current from the lighting circuit. Our London contemporary, "The Electrician," in commenting on the Fulham accident, refers to this system of protection as follows:

> The safest system of house wiring is that in which the wires are surrounded by an earthed metal tube or sheath which is absolutely continuous and is connected to the outside metal work of all the fittings in such a way that any fault, whether it be from wire, switch or lampholder, must create either a short circuit or an earth. Such a system should always be employed in damp buildings or in places, such as baths, in which condensation of moisture is liable to occur on the walls and fittings. It is difficult to ensure that all fittings are water and steam-tight, but in these circumstances leakage from a fitting would be harmless until it was detected. In view of the publicity which has been given to this sad case, we need hardly add that the proprietors of all public baths at which electricity is employed would do well to have their installations thoroughly examined in order to see that they comply with the conditions for absolute safety mentioned above. In baths there is absolute risk of dangerous shock if such a system is not adopted, but we do not wish to imply that in all other cases in which dampness may occur fatal shocks are to be anticipated if the wiring is carried out by a different method. All likelihood of shock, even of slight shock, should be avoided, however, and while almost any of the recognized methods of wiring now in vogue may be adopted without hesitation in ordinary circumstances, it should be borne in mind that the above precautions are simple, inexpensive—and good engineering.

The prospects of success for the 1,000-ton barge canal scheme in the New York legislature appear to be waning. In the Senate on Jan. 22, Senator Lewis offered a resolution asking the Congressmen from New York to work for a full survey of the State canals, in order that the government may acquire them, and construct a ship canal in their place. On the following day Senator Ambler offered an amendment to the State Constitution permitting the disposal of the canals to the national government. In speaking upon this resolution he said:

> I am opposed to the proposition to construct a barge canal or any of the canal improvement schemes. The work of canal improvement ought to be done, if by any one, by the United States Government. There is hardly a grange in this State that has not passed a resolution against the barge canal scheme. The State Grange will take up the matter on February 2 at Syracuse. The farmers say that, as the constitution is now, a barge canal would have to be paid for by direct taxation. They also think a barge canal would bring in products to compete with their products. Then they do not believe the barge canal will be used, even if constructed. The present canal is not used to a third of its capacity.

A canvass of the legislature by the New York "Evening Post" has developed the fact that a considerable number of the members are in much doubt as to the wisdom of the barge canal proposition, and not a few are disposed to favor turning over the canals to the United States.

The plans for financing the barge canal scheme without any direct State tax have fallen through, as a result of the court decision declaring the Franchise tax law unconstitutional. This makes it extremely unlikely that the canal bonds can be met without assessing the taxpayers directly, and it is well understood that it is only by putting the burden of the canal's cost on indirect taxation that the canal bill is expected to be carried through.

The chief support of the barge canal scheme appears to come from the newspapers of Buffalo and New York city, but an important exception to this is the New York "Sun," which in a recent issue has taken strong ground on the other side. We quote from its editorial as follows:

> Probably it will be some time before the canal proposition in the legislature assumes definite form. Nevertheless, we might as well speak our mind about it now. We are against it root and branch, first, last and all the time.
>
> We have never been able to find any satisfactory

answer, in the first place, to the objection brought against the canal scheme, that, even if it was wise, it was a project of national rather than State usefulness, and the cost of constructing and working it, therefore, should be assumed by the Federal Government rather than by any single State. The most important function of the canal will be to transfer the products of the West to the Atlantic seaboard. Directly, the first persons to be benefited thereby will be the Western producers, in that the cost of laying down their grain in the market will be greatly lessened; indirectly, such a matter benefits the nation as a whole; the great mass of the people of New York State will profit little more from a barge canal through the State than will the people of Ohio or Pennsylvania.

Secondly, we have yet to find any evidence of popular enthusiasm over this canal project save in the city of Buffalo and among a few people in the grain and shipping business in this city. We do not believe that it is the duty of the State to issue its bonds for $250,000,000 for the purpose of enlarging and making additionally remunerative the grain elevator business in Buffalo—for all the canal projects are based upon the idea of transshipping or turning over the grain at that port on Lake Erie. So far as the grain-shipping trade here is concerned, it must also be a question as to how great a proportion of the business of shipping coarse and heavy products can be retained in a city where the expense of conducting such business is as necessarily high as it is in our own. Moreover, terminal charges at this port have long been unnecessarily high in the opinion of disinterested observers, and the present scheme is simply a method of taxing the people for the continuance of these charges.

Thirdly, if the people really want to do something as a State to reduce railway freight charges, they can build a railroad along the bed of the present Erie Canal. Such a scheme would be far more effective and cost far less than a $250,000,000 barge canal.

The simple truth is that this whole barge canal agitation is the most extraordinary instance in our time of a delusion as to existing power and importance attaching itself to a mere vestige of something passed. Time was half a century ago, when the possession of the one great artery of inland communication in the country was of immense and peculiar value to the State of New York. But there are now scores of such arteries. The advantage formerly received by us was in the very nature of things, fleeting. Our State can never again hope to enjoy it; and the plan of expending millions of dollars wrung from our already heavily burdened taxpayers, with the idea of galvanizing the Erie Canal into life, is a dream of stupendous ignorance and folly.

THOUGHTS SUGGESTED BY THE AUTOMOBILE EXHIBITION.

AUTOMOBILE: A machine for assisting people of wealth to dispose of their surplus money.

This appears to us a fairly satisfactory definition of the prevalent type of vehicle on exhibition last week at Madison Square Garden.

Several years ago, when the craze for mechanically propelled vehicles first struck this country, and all sorts of ridiculous names were being coined to apply to them, we suggested that they be given the general name of "Motor-vehicles," and that specific varieties be called "motor-wagons," "motor-trucks," "motor-carriages," "motor-cabs," etc. That was when people were looking forward to a general use of mechanical motors to propel all sorts of vehicles. The industry has not developed in this direction at all, however; and for the style of machines at present in vogue we are free to confess that "automobile" is a better name than "motor-vehicle."

Put in plain terms, the use of the automobile to-day is a fashionable fad, imported directly from Paris, and it is certainly appropriate that the French term should come along with it. "Motor-wagon" might do for a vehicle to work at the plebian task of hauling freight, but "automobile" is without doubt the proper term for my lord's or my lady's shining turnout, which is as a rule either imported from Paris or designed on lines closely following the machines which have proved popular in the gay French capital.

Bearing this in mind, it is not strange at all that the development of the "automobile" has not proceeded at all on the lines which seemed probable six or seven years ago. In reviewing the prospects of the motor-vehicle about that time we said:

> Such traffic (pleasure and recreation traffic, or purely personal use) forms a very unimportant part of the whole traffic, both in its amount and in its value to the community, and the motor carriage to be of the greatest good must be applicable to use by the grocer and expressman and cab driver, and to other common everyday employments.

We see no reason even now to change this view. It is a whim of fashion that has turned the development of the motor-vehicle almost wholly toward the direction of a rich man's toy. The designers and builders of mechanically propelled vehicles have found large profits in building racing cars for men who cared nothing what price they paid, so long as their car could win. No wonder, then, that the far more difficult task of producing machines to compete with the horse in doing practical everyday work has been put one side.

We judge that the Madison Square Garden exhibit included at least a hundred vehicles for passenger use, nearly all of them approximating in design to the French "touring car" type. In contrast with these there were possibly half a dozen vehicles for freight transport.

Of course it is fair to add that the automobile show is attended by the class of people who buy vehicles for pleasure use, and that the sale of freight vehicles is very little fostered by such exhibitions. Such development of the motor-vehicle for business use as is taking place, therefore, is hardly represented by the show just closed.

The pleasure automobile, which some years ago exhibited a variety of forms, has now gravitated to one main type, the French touring car. These cars are structurally characterized by a long wheel base, a low body, necessitating a large machinery casing over the front of the body, and seats for the passengers placed well to the rear. They are built throughout for speed, and are equipped with relatively very high powered engines; 10 to 20-HP. engines are the usual thing, while one car shown, accommodating at most about eight persons, was stated to be equipped with engines of 60 HP.

The light runabout seems to have lost ground in the last few years, and, moreover, it seems to be approaching the touring car in design. Its original high body, short wheel base and "buggy-spring" suspension have been modified, and while it is still of light weight compared with the touring car, it has been designed to make higher speed and stand correspondingly hard usage.

Of the automobiles exhibited at Madison Square Garden, there are comparatively few that were operated by steam, and these were comprised in the exhibits of only two or three builders. Electric automobiles were still more scantily represented. The gasoline engine seems to have forced both the electric motor and the steam engine to the rear. Several builders who were formerly identified with the manufacture of steam wagons exclusively are now making gasoline machines. At least one large concern, which took as its special field the exploitation of electrically propelled motor-vehicles, exhibited gasoline cars by the side of its electric vehicles. The representation of the makers of machine parts and accessories demonstrated the same fact: the gasoline engine and its fittings were most largely in evidence.

This fact speaks strongly for the preference which both builders and users give to the gasoline-driven motor-car. It is a simpler machine than the steam vehicle; there is only the engine, with its accessories, and the tank of oil (sometimes also a cooling-water system), as compared with an engine and a boiler, a tank of oil and a tank of feed-water, a corresponding duplication of pumps, and a more complex control mechanism. The greater simplicity of the gasoline vehicle results in the lay user of the machine becoming familiar with it more readily, and simplifies care and maintenance. The absence of water (at least in the air-cooled types of gasoline engine) is another advantage which it possesses over the steam engine.

We may venture the guess that a chief reason for the preference of the gasoline vehicle to the steam propelled is the trouble with the boiler and furnace of the latter. These troubles are largely due, it seems to us, to the attempt to make an extremely small and light boiler develop an abnormally large horse-power, and this again is due to the craze for speed, and to the addition of weight necessary to enable the vehicle to endure the stresses of high speeds. The drift toward the gasoline engine, therefore, may be only temporary, and when people are content to ride over common roads at moderate and safe speeds the steam vehicle may regain its favor.

The simplicity of the electric vehicle has always been a strong point in its favor; but its fatal dependence on the charging station has made it wholly unable to compete with the gasoline machine as a touring car. Besides this its storage battery must have careful handling and attention, and at best it is heavy, delicate and expensive. Largely or wholly due to the battery, the maintenance charges on electric vehicles are high. Away from cities where charging stations are accessible, an owner usually must install a charging outfit on his premises, which adds not inconsiderably to the total cost of his vehicle. Until the frequently prophesied but long delayed improvements to the storage battery becomes a reality, the electric vehicle is not likely to cut any larger figure in the automobile field.

Although the craze for speed and the prevalence of automobilism as a fashionable fad have worked harm to the motor-vehicle industry in some respects, they have, on the other hand, fostered a rapid progress in mechanical design which will be of large service when the industry begins to develop along more permanent lines.

While the difficulties in the way of a motor-vehicle to compete commercially with the horse are far more evident now than they were a half dozen years ago, the means for overcoming them are also nearer at hand. The supplanting of the horse is likely to be a very slow process. No such quick victory as was won by the trolley over the horse car need be looked for. At the same time, the development of the motor-vehicle in the field of pleasure has given a stimulus to inventors, manufacturers and investors which will yet bring about the successful commercial motor vehicle.

LETTERS TO THE EDITOR.

Errors in Johnson's "Framed Structures."

Sir: My attention has been called to the erroneous diagrams of "Engine Loadings E 25 and E 40," as given by this author, page 108a, edition of 1902. These diagrams were the tentative ones published at first for discussion, and are not those now in general use. The tables on page 108b, however, are for the correct engines.

Theodore Cooper.

35 Broadway, New York, Jan. 23, 1903.

Cementation of Road Materials.—A Correction.

Sir: In your review of my paper on the "Cementation of Road Materials, and the Plasticity of Clays," read before Section D of the American Association for the Advancement of Science, at its recent meeting in Washington, your reviewer has not properly presented my views. He makes me say that plasticity is due to hygroscopic water contained in a rock. That is precisely what I did not say. I called attention to the fact that in many rocks and most clays we find more than one kind of combined water. It is that kind which differs from hygroscopic water as well as from water of crystallization and from hydroxyl water, which is a measure of the plastic quality of a clay. Plasticity, in the theory of the writer, is a question of the presence of inorganic colloids. A paper containing the account and results of the investigation is at present in the course of preparation, and will be published as soon as possible.

Respectfully. Allerton S. Cushman.

U. S. Dept. of Agriculture, Bureau of Chemistry,
Washington, D. C., Jan. 15, 1903.

The Compensation of Engineers—and Jockeys.

Sir: Apropos of the recent discussion of this subject in your columns, I am prompted to send you the following newspaper clipping which I have just run across:

VANDERBILT GETS RANSCH.

San Francisco, Jan. 10.—J. S. McDonald to-day paid $5,000 to Burns & Waterhouse for the release from the contract of Jockey Ransch, and signed the boy to ride abroad for W. K. Vanderbilt at a salary of $10,000 a year, with the privilege of renewal for two more years.

What does he pay his chief engineer?

Yours ponderingly, L. H. F.

Steubenville, O., Jan. 15, 1903.

Sir: To settle this idle controversy about the "Compensation of Engineers" I will point out that the cause is not in doctors, butchers or bakers, but in ourselves; and in order to produce a different effect hereafter we must look to ourselves for the remedy. This whole matter was thoroughly comprehended by Emerson, who in his endeavor to enlighten us, gave us his essay on

Compensation, which can readily be procured in convenient pocket editions. It was still better comprehended by Him who painted the truth large: "For whosoever hath, to him," because he attracts; "but whosoever hath not, from him," because he repels or repudiates.

In short, if we would rise above our present standing and heart-burnings, we must follow the instruction of Sidney Smith: "The true way to attack vice (giving the word its proper use), is by setting up something else against it."—Edinburgh Review, 1810.

Truly "this is a busy world, and the age is calling for men who can help bear its burdens, who can do things, whose faces are turned toward sunrise; there is no place for the man who lives in the squabbles of the past."—The Philistine, Jan. 1903.

Yours respectfully, "Try and I."

Scranton, Pa., Jan. 17, 1903.

The Tallest Leveling on Record.

Sir: Many engineers will remember the good story told of an officer on the staff of the late Gen. Q. A. Gillmore during the siege of Charleston. The officer was ordered to place a heavy gun in the middle of a difficult swamp, and to make out a requisition for whatever he required to accomplish the task. In due time the officer presented his requisition which, to the amazement of the Commanding Officer, read as follows:

"Send me a company of men 100 ft. tall to wade through a swamp 40 ft. deep."

The writer was reminded of this story during a recent experience in Alaska, where he came as near fulfilling the specifications of Gilmore's old requisition, perhaps, as anyone has ever done. The work in question was a hasty preliminary survey of a water-power development. The fall in the stream was located some two miles back from tide-water, through such a dense jungle of alder, vine maple, devil's club, blackberry and fern thicket as only Alaska can produce. After spending nearly an hour in "threshing brush" and getting only a few hundred yards up stream from the beach, I decided to attack it in another way; so, climbing a hemlock tree (whose branches made a very good stepladder), when nearly to the top, I found I could look out over the smaller growth and in the far distance catch the line of white foam where the river broke over the upper rapid. Lowering a string to the ground, the telescope and bubble of the level was hauled up and securely placed upon two convenient branches, and with this tree for a tripod (or rather unipod) I was able to determine the elevation of the rapid with sufficient accuracy for the immediate purpose. Dropping one end of the tape line, I found the elevation of my instrument to be 92.3 ft. above the ground, which I take to be the record of high leveling.

Yours truly, A. McL. Hawks.

102 Berlin Building, Tacoma, Washington, Jan. 4, 1903.

Should Sheeting of Deep Trenches Be Pulled?

Sir: Will you please answer the following questions: Is it the practice of contractors to withdraw sheeting of trenches during backfilling? Is leaving the sheeting in place a protection to water mains? Can the streets be restored to their original condition? Enclosed you will find a sketch which shows the average local conditions.

Very respectfully, C. B. Jansen.

18 Grand St., Kingston, N. Y., Jan. 5, 1903.

[Our correspondent's sketch shows a sewer trench some 18 ft. in depth with two tiers of plank sheeting, one above the other, and a water main in the street about 3 ft. from the side of the trench and about 5 ft. below the surface. The trench is dug through successive strata of loam, sand, hard-pan and loam, and a layer of sand underlays the water main. It would be impracticable to pull the lower sheeting until the backfilling had reached nearly to its top, or half way up the trench; but if pulled then, since the sketch shows cavities back of the sheeting, it is very probable that the movement of the sand from beneath the water main would break the water pipe or spring its joints. It is our opinion that the upper course of sheeting could be pulled with comparative safety, after the backfill had reached as high as the level of the water pipe. Specifications are often drawn to read that the sheeting shall be entirely removed, but he would be a very unwise engineer who would insist upon pulling all sheeting if he had reason to believe that, by so doing, nearby structures would be damaged.

Specifically answering our correspondent's questions, we would say: (1) It is a general practice to pull sheeting during backfilling or afterward; (2) Leaving the lower course of sheeting in place seems in this case desirable to protect the water main; (3) Restoring the streets to their original condition refers to the pavement, and it can be done, though often it is not done.—Ed.]

Effect of Manure on Concrete.

Sir: Your article in your issue of Jan. 1, entitled "Does Manure Rot Concrete?" prompts me to contribute the following data from my own experience.

A cement sidewalk was built under my supervision and when completed it was covered with straw, as freezing weather was expected. The contractor hauled a lot of manure (composed principally of stall bedding) and covered the walk with it. I objected, but had no good reason for my objections except the uncleanliness of it. He claimed to know it would do no harm and it went on thick.

It remained on the walk four weeks. First, we had a rain followed by a snow; then it thawed and then it froze, and when it thawed again, it rained. Such was the weather during the whole of that time. We both had the very best reason to believe the cement had thoroughly set before the freezing and thawing commenced, so the only excuse made to the owner for the rebuilding of his walk was that the urine in the manure had ruined the sidewalk. Fortunately for me the owner had heard me protesting against its use, so all the blame went to the contractor. He confessed to me afterwards that he had not told me the truth at first and that this had been his first attempt to use manure. Neither of us, however, had thought it would do any harm. I remember having a hazy idea that it might discolor the top. The sidewalk concrete was crumbly clear to the bottom, 6 ins. It might be in order now for some college professors to experiment in their laboratories.

I know of a stable near my home which has a concrete wall for a few feet in height. Manure is piled against this wall for months at a time. Since reading about the matter in Engineering News I have examined the wall carefully and cannot see that it has suffered by this. In a livery stable near here there is a place about 10 ft. square, with a few boards around like a bin to hold manure thrown from the stalls. The bottom was of boards, but they rotted quickly, and the owner had a cement floor put down so that, in shoveling up the manure to haul it away, the shovelers could make a clean job of it. It has a slight inclination towards the sewer for drainage. A close examination of this has failed to show any extraordinary signs of disintegration, although it may be said to be always covered with manure heaped high.

The chemical mixture of the cement must undoubtedly have much to do with the matter, if manure has any effect on it. In the meantime for the protection of concrete work the writer will carefully refrain from the use of manure, and perhaps other engineers will do the same.

Yours truly, Ernest McCullough.

Adams Block, Lewiston, Idaho, Jan. 14, 1903.

[The two examples of concrete disintegration thus far recorded as being due to manure show a "rotting" of fresh concrete, probably before it has fully set. It is probable that after concrete has fully set, manure will be found to have very little effect upon it. Can any of our readers report further instances of the use of manure to protect concrete during setting, and whether the results were good or bad?—Ed.]

A Power Ditch Landslide Due to Comminuted Clay.

Sir: Reading Mr. Cambie's article in your paper for Jan. 8 on "An Unrecorded Property of Clay and Irrigation as a Cause of Landslides," puts me in mind of an experience I had with a power ditch for the Kendall Gold Mining Co.

This ditch was constructed so that the water level would be entirely in the native soil, 16 ft. bottom, 1½ to 1 slopes, and to carry 3 ft. of water. During its construction a strata of clay, not unlike the "gumbo" of the Judith Basin in general was encountered. When continually moist it formed an effective barrier to the passage of ground water, but during the construction of the ditch it had ample time to dry up and pulverize or slack to a fineness sufficient to pass an 80-mesh sieve.

It was thought that this fine clay would form an excellent puddle, floating down and sealing up the ditch bottom. On the contrary, when, in the early winter, water was let into the ditch, the places where "springs" appeared and where ultimately a 20-ft. embankment slid down hill and moved a two-story house forward for 2½ ft., were the identical places where these clay seams had dried out. These places have since sealed themselves up, but it took six months to accomplish this.

Respectfully, O. F. Wasmansdorff.

Kendall, Montana, Jan. 15, 1903.

A Troublesome Clay Subgrade and How It Was Successfully Treated.

Sir: The writer was much interested in reading the article which appeared in Engineering News of Jan. 8, by Mr. H. J. Cambie, under the heading, "An Unrecorded Property of Clay and Irrigation as a Cause of Landslides," and would like to add his own small experience with this property of clay.

In the fall of 1899, plans were prepared for the grading of about four miles of road in the town of Goshen, Conn., under the state appropriation of 1899 and 1900. This included the reducing of several long-established and tedious grades, one of which, as an example, will illustrate the object of this article.

The subgrade of this road was composed, mainly, of two substances: rock, generally in the form of ledge, and clay. During the month of April, and sometimes well into May, traveling was well-nigh impossible over this road, otherwise than with a very light load, on account of the thickness of soft, oozy mud which obtained to the depth, in some places, of nearly 2 ft. However, after a leaching process, by the aid of gravity and evaporation, had gone on for some time, or well into the Summer, another phase of the question was presented, in the form

Fig. 1. Profile of Clay Cut and Fill.

of soft, fine and disagreeable dust. This was the natural state before any grading was attempted. I should add that in this state of unsubstantiality first mentioned, the sliding property of the clay, mentioned in Mr. Cambie's paper, was not manifest.

In Fig. 1 is shown a profile of the hill, graded. The natural line shows a maximum grade of 11%, which was reduced to 7.4%, and also a maximum of 10.8%, which was reduced to 6.6%. The maximum cut was 8 ft., and the maximum fill on the center line 7.4 ft. The grading was done in the Spring and Summer of 1900. (See State Highway Commissioner's Report for 1900, p. 176.)

The natural surface in the cut, shown by cross-section, Fig. 2, shows the land to be slightly elevated above the road, allowing the surface drainage caused by the heavy Spring rains and from melting snows to soak into the roadbed and thoroughly permeate the soil, thus causing the almost impassable traveling mentioned above.

When work was commenced on the excavation, which was in the early part of the Summer, the surface of the road was found to be very hard to a depth of about a foot, but when a depth of 2 or 3 ft. was reached, the clay was found to be in an almost liquid state; yet these conditions were found on a side hill in a dry season of the year.

The grading was completed as per plan, and the following Spring while riding over the improvement with the highway commissioner, Mr. James H. Macdonald, these conditions were noted: that whereas it was a task for two horses to draw us down grade through the cut, the entire fill was almost like macadam in its compactness and hardness.

The side slopes through the excavation had slid into the road, entirely filling the gutters, and thereby helping to form a gutter of the road which was the width of the excavation. The fill, on the other hand, being almost the

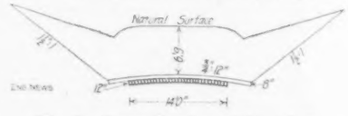

Fig. 2. Cross-Section of Clay Cut.

hardness of rock, suffered none whatever from the attacks of frost or water, and the side slopes had not slid in the least.

To remedy the conditions which had thus arisen, with the aid of State appropriation of 1901 and 1902, a special form of Telford base was built through the entire cut, a distance of 600 ft., and a width of 14 ft. Fig 2 shows the cross-section of roadbed. The Telford specification was as follows:

COURSES.—There shall be two courses consisting of bed stone course of not less than 1 ft. in depth when finished (no allowance for settling in rolling) and one course of 8 ins. after rolling.

BED STONE OR FIRST COURSE.—The bed stone shall be of the following dimensions: not less than 8 ins. in width, not less than 15 ins. in length, and 1 ft. in depth, placed by hand, broadest surface of depth of stone placed down, and stones laid in courses across the road; all joints broken and all interstices chinked in and wedged with broken stone. All sharp points of stone must be broken off with the hammer, to bring the surface of the bed stone true to grade. The bed stone should be laid up full and strong, so as to allow for all settling in rolling. In no case will the contractor be allowed to use stone that is not up to these requirements. After bed stone has been laid, chinked and broken off to grade, the roller shall be run over the bed stone until it is firmly bedded and will not kick or rock under the roller. No nests of small stone will be allowed, nor will the contractor be allowed to use rotten stone.

SECOND COURSE.—The second course shall consist of good dry earth, and put on uniformly so as to leave an even depth of 8 ins. after rolling.

In the above treatment the clay is kept free from soak and the result is a firm, hard roadbed, where before was a shifting, sliding, bottomless mass of mud.

J. P. Wadhams, Ph. B., Civil Engineer.

Torrington, Conn., Jan. 16, 1903.

Stresses in a Circular Plate Subjected to Uniform Fluid Pressure and Supported Around the Circumference.

Sir: In your issue of Jan. 1, 1903, appears an article under the above heading by Mr. H. S. Richmond. Mr. Richmond's reasoning seems to be at fault, as I think the following will show.

He considers a strip cut out of the plate adjacent to a diameter, and having parallel sides. On this strip of a width b, as he states, there is a pressure of $2\,r_1\,b\,p$, while the reactions at the end of the strip amount to $r_1\,b\,p$. He then accounts in a neat manner for the disappearance of the other "$r_1\,b\,p$" by its being taken up in shear by the remaining part of the plate. He also proves that this shear is uniform along the edge of the strip, and the result is a rectangular beam loaded uniformly on its top surface with a load p b per inch and loaded uniformly along one edge with an upward load $\frac{1}{2}\,p\,b$ per inch.

But this seems as far as his reasoning can be considered sound. This rectangular beam is not free to deflect as a simple unrestrained beam, since it must follow the shape taken by the entire plate. Its stresses will therefore not be of necessity those of a simple beam.

A feature of the circular plate which this method of reasoning loses sight of is the assistance which annular stresses render to the supporting of the load. The plate could be cut with circular slits as shown in the accompanying Fig. 1, thus destroying the continuity of the radial fibers. The entire load would then be taken by annular stresses, the metal between the top and bottom rings taking the shear.

Again, following his line of reasoning it could be shown that the stress at the center of the plate is infinite. For, if we consider the load on the two sectors bounded by diameters A B and C D, Fig. 2, it is clear that no shear

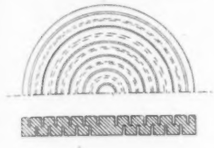

Fig. 1. Plate with Concentric Grooves for Interrupting the Transmission of Radial Stresses.

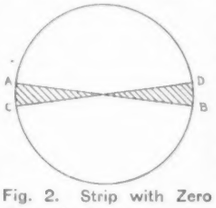

Fig. 2. Strip with Zero Cross-Section at Center.

will be carried across the sections A B and C D. These sectors must therefore support the load coming upon them. But, as the cross-section of the two sectors as a simple beam tapers down to a line at the center of the plate, the fiber stress there would be infinite.

Another statement made by Mr. Richmond, which might be questioned, is that applying Poisson's ratio the "true" stress would be two-thirds of that found analytically, on account of the fact that there is an equal stress at right angles to the one found, acting on the same fibers. Would Mr. Richmond make the statement that the "true" stress on the fibers of a hollow sphere under internal pressure is two-thirds of that which will balance the pressure? It would be nearer the truth to say that the fiber stress for which the plate should be designed (if we accept the principle of Poisson's ratio) is two-thirds of that found analytically.

Edward Godfrey.

Monongahela Bank Bldg., Pittsburg, Pa., Jan. 2, 1903.

Sir: In the analysis of this problem, as given by Mr. H. S. Richmond, in Engineering News of Jan. 1, 1903, p. 14, there would appear to be a very serious omission, by reason of which the result announced for S in equation (10) of the communciation, viz.,

$$S = \frac{3\,p\,r_1^2}{2\,d^2}$$

is rendered altogether incorrect, in the opinion of the present writer.

Reference being made to the same figure as that used by your correspondent (here reproduced as Fig. 3) attention is called to *all* the stresses acting on the two faces of each of the notches of the saw-tooth outline forming one edge, B A, of the half-strip B O, of the uniform width b. Mr. Richmond has noted the fact that each radial face carries no shear and that the sum of the shears acting on the other (cylindrical) faces amounts to one-half the load carried by the half-strip B O. That is, among the forces acting on these faces, he has considered only those which have components perpendicular to the plate; and has apparently overlooked the existence of the tensile and compressive stresses (directed parallel to the plate and thus having no components perpendicular to it), which act on the faces of each notch.

These latter stresses form couples, one for each face of each notch, and these couples must be reckoned with, in forming the expression for the (bending) moment of the couple acting on the end-face A O of the half-strip B O, as well as those forces which have components perpendicular to the plate (viz., the reaction and the shears). Each of these couples can be replaced by two component couples, one with an axis perpendicular to A O and the other with an axis parallel to A O. The algebraic sum of the moments of the couples in this latter set will help to form the expression for the bending moment at A O, and has evidently been overlooked by Mr. Richmond. The introduction of the moments of these couples, however, into Mr. Richmond's treatment would bring into play certain "outer fiber" unit stresses which are *unknown functions* of x and must remain so, thus bringing the analysis to a stand-still, so long as no finer subdivision of the plate is attempted than that represented by Mr. Richmond's strip.

A successful analysis of the problem can be based on differential equations obtained by the consideration of an elementary portion of the plate lying between two radial planes separated by the infinitesimal angle $d\alpha$ and two concentric cylindrical surfaces, centered at O, their radii differing by dr. Such an analysis has been given by Dr. H. T. Eddy, of the University of Minnesota; also by Grashof in his "Festigkeitslehre," and by Professor Lanza in his "Applied Mechanics;" all leading to the result (when Poisson's ratio is taken as $\frac{1}{3}$),

$$S = \frac{5\,p\,r_1^2}{4\,a^2},$$

in place of Mr. Richmond's equation (10). Dr. Eddy's paper is entitled "Theory of the Flexure of a Thin, Flat, Circular Plate or Ring, Loaded Symmetrically about its Center," and appeared some years ago in a technical journal published in the University of Minnesota at Minneapolis. Correspondence on this same problem was published in Engineering News, of January-June, 1900, pp. 10, 162 and 227.

A word of comment may perhaps be permitted on the use by Mr. Richmond of the terms "apparent stress" and "true stress" in the latter part of his communication. Since the stress denoted by the symbol S, as used above, and in Mr. Richmond's analysis, is the *actual* (or true) stress normal to plane A O near surface of plate, it seems odd to apply to it the name of "apparent stress." The quantity called "true stress," or T, by Mr. Richmond, a value which he takes as equal to $\frac{2}{3}$ S (with Poisson's ratio $= \frac{1}{3}$) is evidently what Cotterill designates (p. 437; fourth edition, "Applied Mechanics") as "equivalent simple stress"; that is, the simple longitudinal stress, as in an ordinary testing machine, which would produce a longitudinal elongation equal to the actual elongation in a given case, regardless of the fact that the accompanying lateral contraction as produced by this longitudinal stress in the test-piece of the testing machine would be different

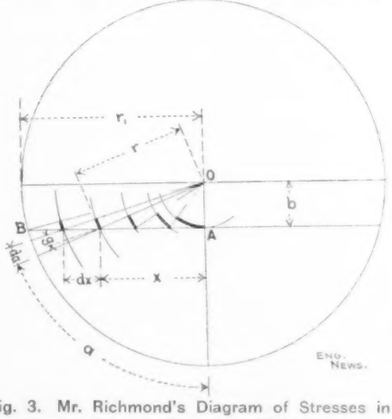

Fig. 3. Mr. Richmond's Diagram of Stresses in a Circular Plate Subjected to Fluid Pressure.

from that existing in the actual state of stress considered. For the test-piece there would be, of course, no lateral stress (although there is a lateral "strain"). As this "equivalent simple stress" is purely ideal, the propriety of calling it the "true stress" seems fairly open to question.

Sincerely yours,

I. P. Church.

Ithaca, N. Y., Jan. 3, 1903.

(Proof of the above letters was submitted to Mr. Richmond and his reply is appended.—Ed.)

Sir: Regarding the preceding letters of Mr. Godfrey and Prof. Church, criticising my letter published in your issue of Jan. 1, 1903, I will reply to both simultaneously, as they both cover the same points.

Mr. Godfrey's illustrations, Figs. 1 and 2, would seem to come under Prof. Church's statement as to the effect of the couples acting on the faces of each notch. These couples were not overlooked as appears to Prof. Church, but were neglected, as acknowledged in the last paragraph of my discussion. The couples acting on the elementary cylindrical surfaces tend to increase the bending moment in the strip, which effect is more than compensated by the couples acting on the elementary radial planes: The strip next adjacent to the first considered having a shorter span deflects less, thus producing shears parallel to the first strip, which relieve its stresses.

Mr. Godfrey's second example, wherein he presents the case of the strip with zero cross-section at the center seems to take away from my approximate demonstration everything but the error.

The writer disclaims responsibility for the invention of the terms "apparent" and "true" stress. Prof. Merriman makes use of these expressions in his "Mechanics of Materials" (p. 232, 9th edition, revised). Cotterill's "equivalent simple" stress corresponds to Prof. Merriman's "real" stress.

Thanking you for your courtesy in affording me chance for an explanation through your columns, I am,

Respectfully yours, H. S. Richmond.

Hanover, N. H., Jan. 12, 1903.

A Caution to Those Who Discuss the Metric System, Pro or Con.

Sir: Below is a bit of parallel column work. The left column is from Mr. Halsey's paper on the Metric System (Eng. News, Dec. 11, 1902), and the right column is supposed to have been written by a Frenchman opposing the adoption of the English system in France.

If I have a surface 8 ft. long by 8 ft. wide and I wish to find its area, I multiply 8 by 8, whereas if the same surface has been measured in metric units I must multiply 2.438 by 2.438.	If I have a surface 3 meters long by 3 meters wide, and I wish to find its area, I multiply 3 by 3, whereas if the same surface has been measured in English units I must multiply 9 ft. 10 7-16 ins. by 9 ft. 10 7-16 ins.

The metric discussion can be carried on ad infinitum, each side gathering together its own carefully selected examples; but it is rather hard on everyone concerned to have to digest a page of such metric letters every week in Engineering News. Can we not hear from some one with experience in both systems who is anxious, not to prove that he is right, but to prove that which is right.

Yours truly,

John C. Trautwine, 3d.

257 S. Fourth St., Philadelphia, Jan. 17, 1903.

A Change of Units of Measure in the Printing Trade.

Sir: Among the many articles opposing the adoption of the metric system the statement is made in nearly every instance that it would be very difficult for mechanics of every trade to become accustomed to its use.

In the printing trades within the last ten years a complete change in units of measurement has been made, and the very existence of a former system has been almost forgotten.

In the former system names were given to each size of type and these different sizes were cast to fractions of an inch, thus: ½-in., paragon; ¼-in., great primer; 1-6-in., pica; 1-7-in., long primer; ⅛-in. bourgeois; 1-9-in., brevier; 1-10-in., minion; 1-12-in., nonpareil, etc.

A type-founder conceived the plan of taking a convenient unit and casting all type and material on multiples of that unit. He chose as this unit 1-72-in. and called it a "point," and for the larger bodies 1-6-in. and called it a "pica," this "pica" being thus twelve "points."

Now we have all printers' material cast on multiples of these units, "12-point" corresponding to the old "pica," "10-point" to "long primer," "8-point" to "brevier," "6-point" to "nonpareil," etc. A saving of two-thirds of the time of composition has been effected, and I see no reason why the unit chosen could not have been of the metric system.

However, the point which I wish to bring out is that in less than ten years a complete change in a system of measurement used by probably 200,000 mechanics in this country has been effected, in fact so complete a change that one who even knows the old system is now an exception, and I see no reason why the metric system, which is more simple than the "point" system could not be universally adopted in at least the same length of time.

Yours truly,

E. M. Malmquist,

Member Typographical Union No. 8.

3324 Bell Ave., St. Louis, Jan. 18, 1903.

A Reply to an Anti-Metric Champion.

Sir: The letter of Mr. Chas. T. Porter against the metric system, appearing in your issue of Dec. 25, and beginning with the word "ABSURD," is of such an extravagant nature that it is difficult to take it seriously, but I shall attempt to do so.

"To begin with," Mr. Porter arraigns "the metric system against itself as absurd," founded on a childish idea, essentially French! Strange that such men as Lagrange, Laplace, Monge, and Condorcet should have fathered it. And Monge an engineer, too! But Mr. Porter probably thinks they were childish. Many Englishmen think French a childish "lingo." But does Mr. Porter forget that the Germans adopted the metric system, probably out of admiration for these childish Frenchmen,

whom they had just beaten in a great war? But then, the Germans are "theoretical, visionary" people, and only occasionally build anything to sell.

Mr. Porter next attacks the meter because it is a little too short, quite regardless of the fact that it is not defined as the ten-millionth of the quadrant, but as the length of a particular bar kept in a cellar at the International Bureau of Sèvres, and practically represented by 30 copies distributed among the 20 or more nations signatory to the Convention of the Meter, of which the United States is one. These copies differ from the original by two or three parts in a million. Can anyone tell me how many copies of the English yard there are, who has them, and how exact they are?

We then are told that "the metric system is absurd in confounding together weights and measures, things which are entirely dissimilar and unrelated, and applying the same system of division to both." How dreadfully illogical it must be then to divide a dollar into a hundred parts, and to divide a thermometer scale, which is so "dissimilar and unrelated," also into a hundred parts. But I forget—this thermometer is not used by our mechanical engineers, but only by those childish French, and it was invented by a Swede. "Physicists," it seems, "deal with minute quantities, and do not measure, but weigh." This is news, indeed. Physicists, I had supposed, did occasionally measure lengths, from those of a light wave to the diameter of the earth's orbit. Physicists generally suppose that it is handy to know how much the water a vessel will hold will weigh, when its size is given. I suppose engineers prefer to figure it out.

Absurdity number three, confessed by the metricists, they "found themselves compelled to employ three units, the additional ones being the kilometer for land measures, the millimeter for mechanical measures, thus making necessary the use of three decimal points." This is similar to the argument against our currency, that it requires three units, the million dollars for the national debt and for captains of industry, the dollar for the wage-earner or the contribution box, and the cent for newspaper purchase, and I believe there are parts of the country where the nickel is the smallest practical unit, the question of subdivision having proved too difficult. Of course, we know that all English-speaking people use only the foot, a natural and sacred standard, and that the distance from here to England is measured in millions of feet, and the fit of a plug gage in millionths, using only one decimal point.

"Fourthly, the metric system is absurd in forbidding the use of division by natural bisection." So is a dollar. Will Mr. Porter inform me how many times you bisect an inch to get a thousandth, which is sometimes used in our shops. Oh, the dear and natural sixty-fourth! And the one-hundred and twenty eighth! And then the two-hundred and fifty-sixth! How many thousandths in the latter? Draftsmen, quick! I am told that in the drawing office of the General Electric Co. there hangs a large chart, giving the decimal values of the results of bisection, so that every draftsman can see it. At any rate I know that Brown and Sharpe's micrometer calipers in the inch system are covered all over with hieroglyphics for the same purpose.

The crowning absurdity of the system for Mr. Porter is exemplified in the statement that 38 ft. are 11,558 mm. "and these five figures and two letters must be written. Nice to remember!" Now it is a singular thing, but if a shaft is half a meter in diameter, it is 19.685 in., also five figures and two letters. Equally "nice to remember." But as a matter of fact, how does the metric system work in a shop? You give your machinist a ten or fifty centimeter rule, divided in millimeters. All he has to learn is these two names, which takes him about a minute. That is all, for I do not suppose there is an intelligent machinist in the United States (and most of our machinists are intelligent), that does not know that there is only one number, ten, in the metric system, and that its great advantage is that it fits our number system, so that there is no calculation. With his rule and his micrometer, reading to hundredths of a millimeter, he is equipped. And in a week he will be as anxious to return to his dear sixty-fourth and thousandth of an inch as he is to go back to the pounds, shillings, and pence, of his ancestors. Ask the Wilians Engine Co. if I am wrong.

It seems to me that the opposition to the metric system arises from a certain state of mind. I am willing to grant that the United States is a "world-power," grant that she is the greatest power, grant that we are smarter than anybody else, grant that we build more machines and sell more goods—I will *not* grant that we are the whole world, or that we can compel them to adopt our ridiculous measures. Every consul in Europe is telling you that if you will not print catalogues in their languages, and use the metric system, you cannot sell your goods there. I am willing to grant that engineers are our most important citizens, but what right have they, or any business men, to ignore the time wasted by 70,000,000 of people in learning all the useless tables of grains, pennyweights, ounces, pounds, inches, feet, yards, poles, perches, chains, rods, furlongs, miles, gills, quarts, pints, gallons, pecks, bushels, *et cetera ad nauseam*. Have our children and the hundreds of millions to come no rights? I do not undertake to capitalize the value of this lost time, but time is money. No, gentleman, my anti-metric friends, you may set back the hands of the clock, but you can't stop it. The American mechanical engineer is as smart as anybody going, and he cannot be put to sleep. The time is not far distant when he will recognize, if he does not already, that his interests are identical with those of the rest of the world.

Yours truly, Arthur Gordon Webster.

Clark University, Worcester, Mass., Jan. 8, 1903.

Notes and Queries.

The photograph of the late Abram S. Hewitt, published in our last issue, was by Rockwood, of New York. Credit was inadvertently omitted in its publication.

R. T. asks where he can find information as to the tractive resistance of various kinds of roads and pavements. In our issue of March 6, 1902, Prof. I. O. Baker, summarized in tabular form the data of Morin and others, and gave in addition some valuable data based upon his own experiments on tractive resistance.

In the Construction News Supplement to our last issue we erroneously gave the name of Mr. Geo. K. Crandall as being the Secretary of the Connecticut Society of Civil Engineers. The Secretary of the Society is Mr. J. P. Jackson, of New Haven, Conn., who took the place of Mr. Crandall on the resignation of the latter, a number of months ago

THE WORK OF COUNTY ENGINEERS ON ROAD CONSTRUCTION IN NEW JERSEY.*

By James Owen,† M. Am. Soc. C. E.

Unlike other States, where State road construction is under way, the county authorities in this State, under the provision of the road statutes, have direct control of all road work through their county commissioner and his supervisors. These provisions of the law practically place the control of all the constructive road work in the hands of the county engineers.

The function of an engineer on public work is somewhat different from that in private undertakings. If he is employed by an individual he is expected to do as that individual wishes or desires, and the engineer is responsible only to him. In public work, however, the procedure is somewhat different and the responsibility more complex.

Most expenditures for public work are under the provisions of various statutes, and these statutes prescribe, more or less, the procedure of the expenditure, in all cases vesting the power in some designated official to be commissioner, freeholder or alderman, and having power directly or by implication to employ the necessary engineer.

If the given commissioner in the exercise of his functions requires legal advice, he goes to a lawyer, gets the necessary advice and follows it. If he does not, he runs the risk of censure on the performance of his duties. When, however, an engineer is employed, in many cases his specific work is detailed and his responsibility is merely for these details. As a matter of principle, however, the practice in the engagement of the lawyer should be followed in the engagement of an engineer. When a piece of construction is necessary, and an engineer has to be engaged to do it, then the whole responsibility should be placed upon the engineer's shoulders, and the responsibility of the commissioner limited to his selection of an engineer.

It is pleasing to note, therefore, that the tendency of to-day is to throw more responsibility upon the engineer. A good engineer is always ready to assume it, and the public now rather looks to opinions and results from the engineer, rather than from the official or officials by whom he may be employed.

Accompanying this responsibility for construction there should also be vested in the engineer the responsibility of the selection of employes and assistants who help him to achieve the final result. However free and untrammeled the engineer himself may be, the best results cannot be attained with assistants who may be at variance with their head, or may be indifferent to his desires, or may be openly hostile to his wants. Such a condition is not ideal, and it is to be regretted that such a condition exists in our road law under which the road supervisors move and have their being. My experience of the supervisor question has not been satisfactory, and, for the better good of the road movement and for the better results for money expended, some change should be made in the appointment of supervisors.

It may be a delicate matter for an engineer to openly allude to the contracting part of road construction, yet the result is so vitally dependent upon the experience, ability, intention and financial condition of the contractor doing the work that it would be remiss not to allude to it, especially as the duties of contractor and engineer are so interwoven that they are practically interdependent.

Given a good, experienced and responsible contractor, with an ample plant and a fair price, the engineer's work is fairly easy and he can sleep well at night; but take the case of an ambitious man with no experience of road work, no money and no plant, and with nothing but the ability to get a bond signed, and the engineer's lot is not an enviable one. In my experience it is impossible to get the best results in such a case, and I presume other engineers here would secretly acknowledge the same result.

In addition, therefore, to supervisors who are trained road builders, the contractors should also be experienced men, but with such an assertion you are confronted with the statement that you are stifling competition. A fair reply can be made to that: First, that up to date very little money has been made on road construction; and, secondly, the amount of road construction, year by year, in the State is about the same, and there are more plants in existence than are necessary for the work, so that it is fair to presume that keen competition can be expected in the future as in the past. The competition of the past has resulted in the survival of the fittest, and the contractors who are now in the business are, as a rule, experienced, capable and well-meaning, and will give the proper equivalent for money expended.

*Extracts from Presidential address at the annual meeting of the New Jersey Association of County Engineers, held at Trenton, Jan. 20, 1903.

†Consulting Engineer, 196 Market St., Newark, N. J.; County Engineer of Essex County.

THE NEW ORLEANS MERGER LAW, under which the board created some time ago to build water-works and sewers was altered and enlarged, has been declared unconstitutional by the State Supreme Court. This leaves the membership of the board as it was at the start.

TERMINAL STATION AND FREIGHT-HANDLING SYSTEM FOR INTERURBAN ELECTRIC RAILWAYS AT CINCINNATI, O.

The builders of interurban electric railways, who have been interested in the operation as well as the mere construction of these lines, have long ago recognized that they should run their cars as nearly as possible into the business districts of the cities which they connect, and not be content to transfer passengers from the interurban cars to the local street cars. While there has been considerable contention between the interurban and local street railway companies as to the methods of accomplishing this result, in many of the larger cities the interurban companies have been able to secure these entrances either by independent tracks or by arrangements made with the local companies for the use of their tracks and power.

It is also beginning to be recognized that these interurban railways must resemble steam railways rather than street railways, and that terminal facilities are necessary for the accommodation of both passenger and freight traffic. For the interurban railways to best conduct their business, particularly where they enter into competition with the steam railways, for both freight and passenger business, it is necessary for them to locate their stations near the centers of the business districts of the cities. In our issue of Aug. 28, we noted a proposed terminal station of this kind at Indianapolis, Ind., where at present the cars of several interurban lines stand on spur tracks on unfrequented side streets.

A very complete system of handling and developing the light freight traffic of interurban electric railways is shortly to be instituted at Cincinnati, O., and work is well under way upon the construction of a large terminal station in the business district of that city for the accommodation of both passenger and freight traffic. This enterprise is the idea of Mr. G. R. Scrugham, who is President and General Manager of the Interurban Terminal Co., of Cincinnati, and the parties interested in the project are the stockholders of three interurban lines: (1) The Cincinnati & Eastern Electric Ry. Co., running southeast to New Richmond, O., 22 miles; (2) the Suburban Traction Co., running northeast to Bethel and Batavia, 28 miles; and (3) the Rapid Railway Co., running north to Lebanon, 32 miles. The total length of the three lines outside the city is about 82 miles, of which 14 miles are double track.

The street railway tracks of the city of Cincinnati have a gage of 5 ft. 2½ ins., and the above roads, as well as the Millcreek Valley St. Ry., which operates northwest to Hamilton, a distance of 18 miles, are constructed with the same gage. Other roads will use the same terminal later. The basis for payment for the use of the terminal station will be according to the number of cars operated and the amount of freight handled.

The terminal station is situated on Sycamore

St., between Fourth and Fifth Sts., within one block of Government Square, which is practically the center of Cincinnati. It is a six-story building, 60 × 160 ft., with a freight shed in the rear, 30 × 80 ft., extending to an alley where teams can transfer freight to and from the station. The first floor is for the cars, passenger waiting room, freight receiving room, etc. A single track will enter the building, but inside there will also be a storage track, connected with the other by a

turesque pleasure ride. (2) The Suburban Traction Co. operates northeast from Cincinnati, and serves a district largely cultivated as market gardens, the products of which are now hauled to the city by wagons, as there are no convenient railway facilities; the line extends to Bethel and Batavia, 28 miles. (3) The Rapid Ry. Co.; this operates north from Cincinnati to Lebanon, 32 miles; it passes through a continuous line of suburban villages, a large majority of the population of

and the rest by scrapers. The structures are somewhat numerous, ranging from small concrete culverts to a three-span truss bridge over the Little Miami River. Many of the arched culverts and bridges are of concrete, but some of those built during the winter have brick barrels with stone facings and wing walls. Trestles are used over a few soft places, where it was feared that solid banks would cause trouble. The track is laid with 70-lb. rails on white oak ties, and in

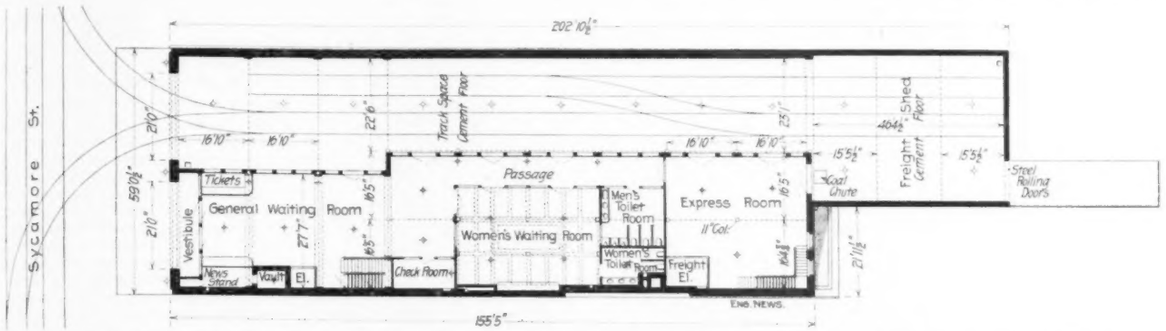

FIG. 1. PLAN OF FIRST FLOOR OF TERMINAL STATION FOR ELECTRIC INTERURBAN RAILWAYS AT CINCINNATI, O.

crossover. This arrangement will provide for handling about 30 cars per hour. A plan of this floor is shown in Fig. 1. The general waiting room will be 30 × 60 ft., and in the rear of this will be a women's waiting room, 24 × 40 ft. The upper floors are all arranged as shown in Fig. 2, and are intended to accommodate the offices of the railways using the terminal station. The arrangement of the partitions can be changed, however, to suit the convenience of different companies. These offices are served by a passenger elevator in the front of the building and a large freight elevator in the rear.

The building is a brick and steel structure, with a granite front for the first floor and Bedford stone front above. It will be equipped with an independent steam heating, electric light and elevator plant. It was designed by Mr. Scrugham; the architects were Werner & Adkins, and the general contractors L. P. Hazen & Co., of Cincinnati. Other contractors were as follows: Steam heating, the John H. McGowan Co.; plumbing and gas fitting, Wm. Hillenbrand & Co.; steam engines, the Buckeye Engine Co., Salem, O.; generating plant for lighting and elevators, Westinghouse Electric & Mfg. Co.; steelwork, L. Schreiber & Sons Co., of Cincinnati. The building will be completed and the three roads in operation in December.

The three railways which the interests of the Interurban Terminal Co. are constructing (outside of the city and villages), mainly own their right of way, which consists of turnpike and toll-roads which have been purchased. In such cases a wagon road is left parallel with the tracks. The remaining portion of the right of way was pur-

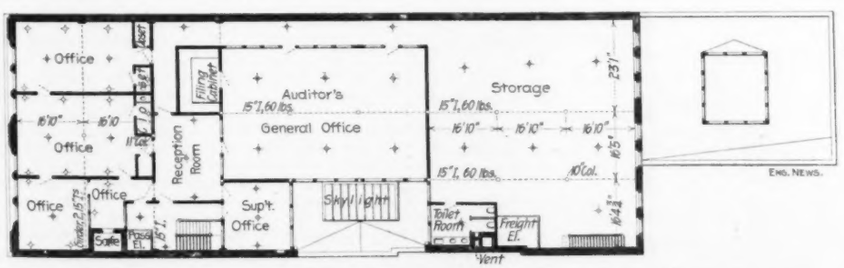

FIG. 2. PLAN OF UPPER FLOORS OF TERMINAL STATION FOR ELECTRIC INTERURBAN RAILWAYS AT CINCINNATI, O.

chased or condemned through town lots, farms, etc. These lines are as follows: (1) The Cincinnati & Eastern Electric Ry. Co.; this operates southeast from Cincinnati through the new waterworks grounds and the town of California, to Coney Island (a large pleasure resort); thence through a number of villages to New Richmond, 22 miles; this road follows very closely the line of the Ohio River, making a very popular and pic-

which are commuters, who depend at present upon the steam railway operated in this territory.

The experience in similar cases with electric railways along the roads and through numerous villages and small towns has been that the railways will not only carry the existing traffic, but will also largely develop and increase the traffic between these towns and the city, and between the towns themselves. In many of the towns, the electric railway companies will establish stations, with a man in charge to act as agent who will operate wagons to distribute and collect goods. The system of transporting these goods on the cars will be very similar to that now in use by express companies; way bills being used, and a regular tariff being established. To facilitate small shipments, the companies will sell books of tickets to paste on the packages for pre-payment, a plan similar to that used by messenger companies.

Small platforms are being built along the land side of the tracks in front of the farmhouses, so that packages, crates of vegetables, milk cans, etc., can be handled directly from each farm. For collecting and distributing freight to and from the terminal station, the company will operate a number of express wagons. The roads will operate regular passenger cars on a schedule varying from 15 minutes to one hour; combination cars which handle light freight will be run every hour; and large double-truck baggage cars will be operated at night for the handling of heavy freight and large shipments to be distributed from the stations in the towns through which the roads operate.

The roads have long tangents and easy curves, but some of the grades are heavy, the maximum being 4¼%. As the country is rather rough and broken there is considerable earthwork, with heavy banks and cuttings; a large number of the banks are faced and covered with broken stone, which is obtained at low cost from the Cincinnati water-works tunnel now under construction. The same stone, broken in a crusher, is also used for ballast. Part of the work is done by steam shovels

most cases the trolley wire is supported by span wires with double lines of wooden poles. In one town, however, iron center poles are used, with ornamental brackets over the tracks.

Large double-truck cars will be used, but no attempt will be made to operate at very high speeds, as it is considered that with the class of traffic and under the conditions prevailing, a moderate speed with frequent stops will be more remunerative. The speed will probably be from 25 to 35 miles an hour.

PLASTERS AND HARD FINISHING CEMENTS IN THE UNITED STATES.

By Edwin C. Eckel,* Assoc. Am. Soc. C. E.

The cementing materials which have been grouped† by the present writer as "Hydrate Cements," agree in being manufactured from gypsum, a hydrous sulphate of lime. In their preparation advantage is taken of the fact that this mineral parts with much or all of its water of combination on calcination; and that the "plaster" resulting from such calcination will, when mixed with water, take up enough to enable it to resume its original composition. Though agreeing in these essential points, minor differences exist in the processes of manufacture and in the properties of the product; and these differences permit the division of the group of hydrate cements into several subgroups. These subdivisions are as follows:

1. Produced by the incomplete dehydration of gypsum, the calcination being carried on at a temperature not exceeding 400° F.

(a) Produced by the calcination of a pure gyp-product, nothing being added either before or after calcination. Plaster of Paris.

(b) Produced by the calcination of a gypsum containing certain natural impurities, or by the addition to a calcined pure gypsum of certain materials which serve to retard the set of the product. Wall Plaster, Cement Plaster.

2. Produced by the complete dehydration of gypsum, the calcination being carried on at a temperature exceeding 400° F.

(a) Produced by the calcination of a pure gypsum, nothing being added, either before or after calcination. Dead Burnt Plaster.

(b) Produced by the calcination, at a red heat or over, of gypsum to which certain substances (usually alum or borax) have been added. Hard Finishing Cements.

Of the four groups above noted the first two (which include plaster of paris and the wall plasters and cement plasters) are well known, and their technology has been extensively discussed in scientific and technical journals. The third group contains the overburned or "dead-burnt"

*U. S. Geological Survey, Washington, D. C.
†"Classification of the Crystalline Cements," American Geologist, vol. xxix., pp. 146-154, 1902.

plasters, which have never, to the writer's knowledge, come into use in this country. The hard-finishing cements, which constitute the fourth group, include the well known Keene's and Parian cements. As these hard-finishing cements are rarely discussed in any detail, some notes concerning the technology of one of them may be of interest to engineers.

KEENE'S CEMENT.—The most prominent representative of the group of hard-finishing cements is that known to the trade as Keene's cement. Originally manufactured under English patents which have now expired, the term "Keene's" is applied by various manufacturers to their product, in the same manner as the term "Portland" has become generalized. Large quantities of Keene's cement are annually imported, while its manufacture in the United States has been of late years successfully begun.

Keene's cement is sharply distinguished from the other members of the group of hydrate cements (or "plasters"), not only by the properties of the product, but by its method of manufacture. In its preparation a very pure gypsum is calcined at a red heat, the resulting dehydrated lime sulphate is immersed in a bath of alum solution; and, after drying, is again burned at a high temperature. After this second burning the product is finely ground, and is then ready for the market. This sketch of the process is a general outline of the methods used, and in the essentials is followed in all plants, though slightly modified at different plants according to the experience gained by each manufacturer.

The gypsum used should be as pure as possible, and especially it should be free from such impurities as might tend to discolor the product, which should be a pure white. Nova Scotia gypsum has been tried and, for some reason, found to be unsatisfactory. Even the Virginia gypsum, which on analysis shows but a trace of iron oxide, is not entirely satisfactory; for on heating to the temperature necessary for the manufacture of Keene's cement, minute red streaks appear in the lumps of gypsum. The following analyses show the composition of gypsum from Virginia and Kansas, both of which have been used in the preparation of a domestic Keene's cement:

	Kansas.	Virginia.
Lime sulphate	77.46 {	99.58
Water	20.46 }	
Iron and aluminum oxides	0.16	0.036
Silica and insoluble	0.19	0.116
Magnesium carbonate	0.54	0.221
Lime carbonate	1.43	...

It will be seen that both materials are very pure gypsums, and that there is no apparent reason why the Virginia material should not be as satisfactory as that from Kansas.

The calcination of the product is usually carried on in small vertical kilns closely resembling those which are in common use for lime-burning. These kilns are charged with alternating layers of fuel (usually coal) and lump gypsum. Small rotary kilns have been used experimentally, but have not proven successful, as the calcined product from a notary kiln is discharged in small fragments which cannot be treated satisfactorily in the alum bath. After burning to a red heat, the gypsum is submitted to the action of a 10% alum solution. It is then recalcined and finally ground in emery mills.

The product is a very finely grained white powder. On the addition of water this cement hardens, but the hardening is slow, relative to that of other plasters. Another peculiarity of the material is that, even after the hardening has commenced, the partly set cement may be reworked with water and will take its set just as satisfactorily as if the process (of hardening) had not been interrupted.

THE REAL ESTATE RECORDS OF A GREAT RAILWAY SYSTEM.*

By H. I. Orwig†

The Chicago & Northwestern Ry. Co. owns nearly 9,000 miles of main line, together with several thousand miles of auxiliary sidings, second track, and spurs to industries, a total of perhaps 12,000 miles of railway, located in nine States, and touching about 1,500 cities and towns. It owns nearly 200,000 acres of land used for right of way and station ground purposes, and several land grants originally amounting to nearly 3,000,000 acres, but now, for the most part, sold to settlers. Through proprietary companies it owns more than 300 town sites, and extensive tracts of land used for various purposes in connection with its business.

All matters relating to lands are in charge of a division known as the Land Department, which is presided over by an official having the title of Land Commissioner. The department employs a considerable force of men, including right of way and land agents, land examiners, timber estimators, surveyors, draftsmen, conveyancers, clerks, etc. The department is charged with the transaction of all business concerning real estate, and with the custody of all land records, and to it are referred all matters in regard thereto. Inquiries are constantly being made in relation to town site, right of way and other real estate matters; purchases and sales are continually taking place, and leases being made, and it is highly essential that the records be in such shape that they can be quickly referred to, and any information desired furnished without delay.

Maps constitute a highly important part of the department's records. Without correct and comprehensive maps it would be impossible to secure that degree of quick reference which is so essential to the prompt dispatch of business. The various purposes for which maps are required necessitate many different kinds of maps. There are maps of right of way, of station grounds, land grants, town sites, gravel pits, etc. Also special maps of every description, of all sorts and conditions, of all sizes, to every scale, on all kinds of paper, and bearing the earmarks of every imaginable degree of servitude. Great care is exercised in the preparation of maps. They are compiled from surveys, and deeds or other instruments of conveyance are carefully checked to insure against possible errors, and are intended to show at a glance the exact status of the company's interest in the premises exhibited thereon.

The care of the railway right of way is an important part of the Land Department's work. There are franchises and ordinances to be secured, right of way, gravel pits and borrow privileges purchased, highways dedicated or changed, claims for damages to land or crops investigated, crossing contracts made with other railway companies, lands leased to industries, squatters kept off, and a long catalogue of other matters to be looked after.

The right of way title papers are kept in tin boxes holding from 60 to 100 deeds each, and arranged alphabetically by counties, each State having its separate section of the vault. The deeds are filed in packages, each township and range by itself, and the deeds in the several packages arranged in numerical order by sections. There are a few exceptions to this plan, as in large cities, when the deeds are filed by wards or other convenient districts.

The maps of right of way are drawn upon mounted eggshell paper, usually 36 ins. wide, and averaging a 10-yd. roll to each county. They are constructed to a scale of 500 ft. to the inch, and show the company's lands outlined in accordance with the descriptions in the deeds, all distances, courses and references being noted in full. They are colored to indicate the nature of the ownership; red signifying that the lands are owned in fee; brown denoting a borrow privilege; yellow, that the title was gained by condemnation proceedings; green that the lands are owned by one of the proprietary town site companies; blue that it has been sold, and so on. The maps show also the name of the company's grantor, and the kind of title the company gained (whether a warranty or quit claim deed, a condemnation, an easement, borrow privilege, or lease), together with a brief note of any conditions limiting the company's title, or requiring it to perform specific acts. These maps are in continuous rolls, by counties; they are kept in pigeon holes, and arranged alphabetically by counties, and in sections by States, in the same manner as the deeds. Maps of station grounds, and of right of way through cities and towns are drawn on tracing cloth to a scale of 100 ft. to the inch, and show, in addition to the right of way, all tracks, buildings and other improvements.

Permanent right of way maps are never made until after the lines have been constructed. In the building of new extensions it is frequently desirable to make changes in the alinement, and consequently in the right of way, and it has been found advisable to defer making permanent maps until after construction is completed. A blue print of the location map is used, in the meantime, to show the right of way, and such changes as are made while the work is being done.

While maps, right of way, as well as all others, are very properly classed among the most important records, their principal value is in their use as abstracts indicating the kind of ownership, and as indices assuring quick access to the deeds, agreements or other papers under which the company claims title to each parcel of land, for in all cases involving ownership, sufficiency of title, or other questions of importance, the title papers are always referred to.

For the keeping of town site records a different plan is necessary. The title papers of each town are kept in a separate package, and the whole set alphabetically arranged. The town site property is listed in ledgers, each tract, lot, block or outlot, being entered as for sale, with columns in which to record the names of the purchasers and their addresses, the serial numbers of the deeds or contracts, the price, and the date of sale. At the head of the schedule of each town is a complete map of the town site, a faithful compilation of all the surveys and recorded plats thereof, to a scale of 200 ft. to the inch, showing the entire tract of land originally owned by the town site company, the railway lines, right of way and station property, and all additions, vacations and sales. This map is always kept corrected to date. Besides the map in the book there is also a tracing of it kept correct to date, from which blue prints are made as may be required by agents, prospective purchasers, or others.

The steps usually taken in purchasing a parcel of land, for whatever purpose intended, are as follows: An option is taken from the owner, following which an inspection is made of his title. Then a description of the premises to be purchased is drawn, and a conveyancer prepares the deed for execution. After it is executed it is returned to the Land Department, and if properly executed, acknowledged and witnessed, it is delivered to one of the department's engineers (usually not the one who prepared the original description), who rigidly inspects it. If he finds it correct, he colors and notes it upon the proper map or maps, indorsing it to indicate that he has so colored and noted it, after which it is entered in a register of land purchases, wherein are shown the name of grantor and grantee, the date of purchase, a brief description of the premises, the price paid therefor, and several other items of information. The document is then sent to the County Register of Deeds to be recorded, and when returned is placed in an envelope, on which are noted the government subdivision, section, township, range, county and State in which the property is situated, together with the grantor's name and the nature of the instrument, after which it goes to join its fellows in the vault.

The deeds for lands sold go through the same process, so far as the same is applicable to sales. When a sale is made, the deed or contract is given to an engineer or draftsman to outline and color the same in blue on the proper maps, and to enter thereon the deed or contract number. No deed is delivered to the purchaser without first having the proper endorsement thereon, indicating that it has been so shown upon the maps. The deeds for lands sold, whether of land grant lands, town lots, or portions of right of way, are consecutively numbered, and entered in a register of land sales which is kept on the same plan as the register of land purchases.

With contract sales, where the entire purchase price is not paid at once, contracts are executed in duplicate, one for the Land Department files and one for the purchaser. These are numbered in the same manner as deeds, except that each division of sales, land grant, town site or miscellaneous, is given a separate series of numbers, and filed separately. Standard forms of deeds are used for land grant and town site sales, and it is not necessary therefore to make copies of such for the files, but in cases of sales where the standard forms cannot be followed, the deeds are copied in full in a special record book. Land grant lands are listed by 40-acre tracts of government lots in tract books, with columns for the purchaser's name and address, the area, the price paid, date of sale, and the deed or contract number.

The land grant maps are constructed on different scales, some showing on a small scale (usually ½-in. to the mile), the entire grant; and other special maps which show portions of the grant on various scales, according to the purposes for which they are to be used. Township diagrams are used to show the ownership, and large section maps to show the kind and quantity of timber on the several subdivisions. Besides these there are sundry blanks which are filled out in response to requests from prospective purchasers, and which briefly indicate the character of the land and timber thereon. At every station, portions of the station grounds are leased to persons for use as lumber yards, elevator and warehouse sites, or for other purposes in connection with railway business. The unplatted town site lands are leased for agricultural purposes, and occasionally some one encroaches with a building, fence or garden, when to avoid causing any hardship, as well as to protect the company's title, a lease is made of the ground so occupied, unless it is required for other purposes.

Several clerks are kept busy writing leases, which are made in duplicate, usually for a term of five years. They are numbered and entered in a record book in much the same manner as deeds, and also in a book called a "tickler," which is divided to show the year and month in which the lease expires.

There are many other matters, such as highway and railway crossings, taxation maps, maps required by law to be filed in government, State or county offices; damages for overflowed lands, questions of accretions and riparian rights, encroachments, topographical and station ground surveys, all of which it is the particular province of the Land Department to look after.

*Abstract of a paper presented at the annual meeting of the Illinois Society of Engineers and Surveyors at Aurora, Ill., Jan. 21 to 23.

†Land Department, Chicago & Northwestern Ry., Chicago, Ill.

REPORT OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS' COMMITTEE ON UNIFORM TESTS OF CEMENT.

At the annual meeting of the American Society of Civil Engineers, held Jan. 20 and 21, 1897, a committee was appointed to report to the Society a uniform method for the manipulation of tests of hydraulic cements. Shortly after its appointment this committee began a series of careful studies and experiments, and has continued this work through the intervening years making brief reports of progress as the work advanced. During 1902 the work had reached a stage of advance which made it possible to compile a tentative report, and at the annual meeting held Jan. 21 and 22 this report was presented to the Society. In many respects this is one of the most important documents relating to cement testing practice which has appeared in English in many years, and we, therefore, publish it practically in full, as follows:

SAMPLING.

SELECTION OF SAMPLE.—The selection of the sample for testing is a detail that must be left to the discretion of the engineer; the number and the quantity to be taken from each package will depend largely on the importance of the work, the number of tests to be made and the facilities for making them. The sample shall be a fair average of the contents of the package; it is recommended that, where conditions permit, one barrel in every ten should be sampled. All samples should be passed through a sieve having 20 meshes per linear inch, in order to break up lumps and remove foreign material; this is also a very effective method for mixing them together in order to obtain an average. For determining the characteristics of a shipment of cement, the individual samples may be mixed and the average tested; where time will permit, however, it is recommended that they be tested separately.

METHOD OF SAMPLING.—Cement in barrels should be sampled through a hole made in the center of one of the staves, midway between the heads, or in the head, by means of an auger or a sampling iron similar to that used by sugar inspectors. If in bags, it should be taken from surface to center.

CHEMICAL ANALYSIS.

SIGNIFICANCE.—Chemical analysis may render valuable service in the detection of adulteration of cement with considerable amounts of inert material, such as slag or ground limestone. It is of use, also, in determining whether certain constituents, believed to be harmful when in excess of a certain percentage, as magnesia and sulphuric anhydride, are present in inadmissible proportions. While not recommending a definite limit for these impurities, the committee would suggest that the most recent and reliable evidence appears to indicate that magnesia to the amount of 5%, and sulphuric anhydride to the amount of 1.75%, may safely be considered harmless.

The determination of the principal constituents of cement—silica, alumina, iron oxide and lime—is not conclusive as an indication of quality. Faulty character of cement results more frequently from imperfect preparation of the raw material or defective burning than from incorrect proportions of the constituents. Cement made from very finely-ground material, and thoroughly burned, may contain much more lime than the amount usually present and still be perfectly sound. On the other hand, cements low in lime may, on account of careless preparation of the raw material, be of dangerous character. Further, the ash of the fuel used in burning may so greatly modify the composition of the product as largely to destroy the significance of the results of analysis.

METHOD.—As a method to be followed for the analysis of cement, that proposed by the Committee on Uniformity in the Analysis of Materials for the Portland Cement Industry, of the New York Section of the Society for Chemical Industry, and published in the "Journal" of the Society for Jan. 15, 1902, is recommended.

SPECIFIC GRAVITY.

SIGNIFICANCE.—The specific gravity of cement is lowered by underburning, adulteration and hydration, but the adulteration must be in considerable quantity to affect the results appreciably. Inasmuch as the differences in specific gravity are usually very small, great care must be exercised in making the determination. When properly made, this test affords a quick check for underburning or adulteration.

APPARATUS AND METHOD.—The determination of specific gravity is most conveniently made with Le Chatelier's apparatus. This consists of a flask (D), Fig. 1, of 130 cu. cm. (7.32 cu. ins.) capacity, the neck of which is about 20 cm. (7.87 ins.) long; in the middle of this neck is a bulb (C), above and below which are two marks (E) and (F); the volume between these marks is 20 cu. cm. (1.22 cu. ins.). The neck has a diameter of about 9 mm. (0.35 in.), and is graduated into 1-10 cu. cm. above the bulb. Benzine (62° Baumé naphtha), or kerosene free from water, should be used in making the determination. The specific gravity can be determined in two ways:

(1) The flask is filled with liquid to the lower mark (E), and 64 gr. (2.25 oz.) of powder, previously dried at 100° C. (212° F.) and cooled to the temperature of this liquid, is gradually introduced through the funnel (B) [the stem of which extends into the flask to the top of the bulb (C)], until the upper mark (F) is reached. The difference in weight between the cement remaining and the original quantity (64 gr.) is the weight which has displaced 20 cu. cm.

(2) The whole quantity of the powder is introduced, and the level of the liquid rises to some division of the graduated neck. This reading plus 20 cu. cm. is the volume displaced by 64 gr. of the powder.

The specific gravity is then obtained from the formula:

$$\text{Specific gravity} = \frac{\text{Weight of cement}}{\text{Displaced volume.}}$$

The flask, during the operation, is kept immersed in water in a jar (A), in order to avoid variations in the temperature of the liquid. The results should agree within 0.01.

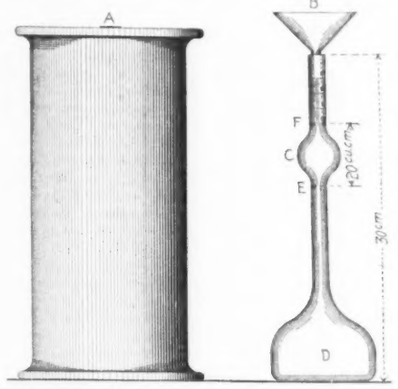

Fig. 1. Le Chatelier Apparatus for Determining the Specific Gravity of Cement.

A convenient method for cleaning the apparatus is as follows: The flask is inverted over a large vessel, preferably a glass jar, and shaken vertically until the liquid starts to flow freely; it is then held still in a vertical position until empty; the remaining traces of cement can be removed in a similar manner by pouring into the flask a small quantity of clean liquid and repeating the operation. More accurate determinations may be made with the picnometer.

FINENESS.

SIGNIFICANCE.—It is generally accepted that the coarser particles in cement are practically inert, and it is only the extremely fine powder that possesses adhesive or cementing qualities. The more finely cement is pulverized, all other conditions being the same, the more sand it will carry and produce a mortar of a given strength. The degree of final pulverization which the cement receives at the place of manufacture is ascertained by measuring the residue retained on certain sieves. Those known as the No. 100 and No. 200 sieves are recommended for this purpose.

APPARATUS.—The sieves should be circular, about 20 cm. (7.87 ins.) in diameter, 6 cm. (2.36 ins.) high, and provided with a pan, 5 cm. (1.97 ins.) deep, and a cover.

The wire cloth should be woven (not twilled) from brass wire having the following diameters: No. 100, 0.0045 in.; No. 200, 0.0024 in. The wire cloth should be mounted on the frames without distortion; the mesh should be regular in spacing and be within the following limits: No. 100, 96 to 100 meshes to the linear inch; No. 200, 188 to 200 meshes to the linear inch. Fifty grams (1.76 oz.) or 100 gr. (3.52 oz.) should be used for the test, and dried at a temperature of 100° C. (212° F.) prior to sieving.

METHOD.—The committee, after careful investigation, has reached the conclusion that mechanical sieving is not as practicable or efficient as hand work, and, therefore, recommends the following method: The thoroughly dried and coarsely screened sample is weighed and placed on the No. 200 sieve, which, with pan and cover attached, is held in one hand in a slightly inclined position, and moved forward and backward, at the same time striking the side gently with the palm of the other hand, at the rate of about 200 strokes per minute. The operation is continued until not more than 0.1% passes through after one minute of continuous sieving. The residue is weighed, then placed on the No. 100 sieve and the operation repeated. The work may be expedited by placing in the sieve a small quantity of large shot. The results should be reported to the nearest tenth of 1%.

NORMAL CONSISTENCY.

SIGNIFICANCE.—The use of a proper percentage of water in making the pastes* from which pats, tests of setting and briquettes are made, is exceedingly important, and affects vitally the results obtained. The determination consists in measuring the amount of water required to reduce the cement to a given state of plasticity, or to what is usually designated the normal consistency. Various methods have been proposed for making this determination, none of which have been found entirely satisfactory. The committee recommends the following:

METHOD: VICAT NEEDLE APPARATUS.—This consists of a frame K, Fig. 2, bearing a movable rod L, which has a cap A at one end, and at the other end a cylinder B, 1 cm. (0.39 in.) in diameter, the cap, rod and cylinder weighing 300 gr. (10.57 oz.). The rod, which can be held in any desired position by a screw F, carries an indicator, which moves over a scale (graduated to centimeters) attached to the frame K. The paste is held by a conical, hard-rubber ring I, 7 cm. (2.76 ins.) in diameter at the base, 4 cm. (1.57 ins.) high, resting on a glass plate J, 10 cm. (3.94 ins.) square.

In making the determination, 500 gr. (17.64 oz.) of cement are kneaded into a paste, as described in a succeeding paragraph, and is then formed into a ball with the hands, completing the operation by tossing it six times from one hand to the other, maintained 6 ins. apart; the ball is then pressed into the rubber ring, through the larger opening, smoothed off, and placed on a glass plate, (on its large end) and the smaller end smoothed off with a trowel; the paste, confined in the ring, resting on the plate, is placed under the rod bearing the cylinder, which is brought in contact with the surface and quickly released. The paste is of normal consistency when the cylinder penetrates to a point in the mass 10 mm. (0.39 in.) below the top of the ring. Great care must be taken to fill the ring exactly to the top.

The trial pastes are made with varying percentages of water until the correct consistency is obtained. The committee believes that the normal consistency should produce a rather wet paste, since this consistency tends to greater uniformity in the mixing, and since there is less liability of compressing the briquettes during the molding. Having determined in this manner the proper percentage of water required to produce a neat paste of normal consistency, the proper percentage required for the sand mortars is obtained from an empirical formula. The committee hopes to devise such a formula. The subject proves to be a very difficult one, and, although the committee has given it much study, it is not yet prepared to make a definite recommendation.

TIME OF SETTING.

SIGNIFICANCE.—The object of this test is to determine the time which elapses from the moment water is added until the paste ceases to be fluid and plastic (called the "initial set"), and also the time required for it to acquire a certain degree of hardness (called the "final" or "hard set"). The former of these is the more important, since, with the commencement of setting, the process of crystallization or hardening is said to begin. As a disturbance of this process may produce a loss of strength, it is desirable to complete the operation of mixing and molding or incorporating the mortar into the work before the cement begins to set. It is usual to measure arbitrarily the beginning and end of the setting by the penetration of weighted wires of given diameters.

METHOD.—For this purpose the Vicat Needle, which has already been described, should be used. In making the test, a paste of normal consistency is molded and placed under the rod L, Fig. 2; the cylinder and the cap A are replaced by the needle H, 1 mm. (0.039 in.) in diameter, and the cap D, the rod L with cap D and needle H, weighing 300 gr. (10.57 oz.). The needle is then carefully brought in contact with the surface of the paste and quickly released. The setting is said to have commenced when the needle ceases to pass a point 5 mm. (0.20 in.) above the upper surface of the glass plate, and is said to have terminated the moment the needle does not sink visibly into the mass.

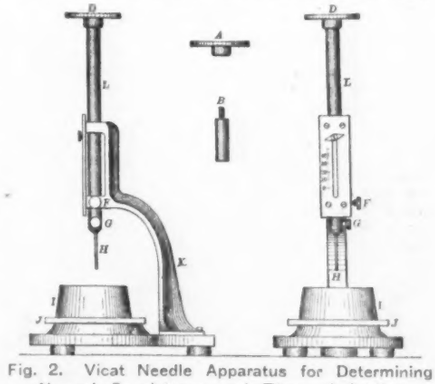

Fig. 2. Vicat Needle Apparatus for Determining Normal Consistency and Time of Setting of Cement.

The test pieces should be stored in moist air during the test; this is accomplished by placing them on a rack over water contained in a pan and covered with a damp cloth, the cloth to be kept away from them by means of a wire screen; or they may be stored in a moist box or closet. Care should be taken to keep the needle clean, as the collection of cement on the sides of the needle re-

*The term "paste" is used in this report to designate a mixture of cement and water, and the word "mortar" a mixture of cement, sand and water.

tards the penetration, while cement on the point reduces the area and tends to increase the penetration. The determination of the time of setting is only approximate, being materially affected by the temperature of the mixing water, the temperature and humidity of the air during the test, the percentage of water used, and the amount of molding the paste receives.

STANDARD SAND.

The committee recognizes the grave objections to the standard quartz now generally used, especially on account

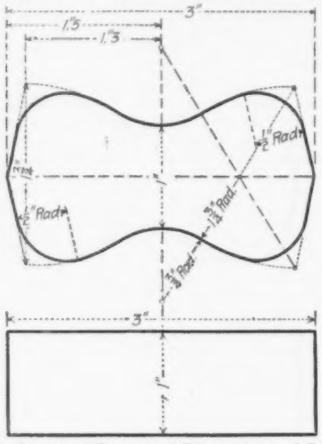

Fig. 3. Standard Form and Dimensions of Briquette for Tensile Tests of Cement.

of its high percentage of voids, the difficulty of compacting in the molds, and its lack of uniformity; it has spent much time in investigating the various natural sands which appeared to be available and suitable for use. For the present, the committee recommends the natural sand from Ottawa, Ill., screened to pass a sieve having 20 meshes per linear inch and retained on a sieve having 30 meshes per linear inch; the wires to have diameters of 0.0165 and 0.0112 in., respectively, i. e., half the width of the opening in each case. The Sandusky Portland Cement Co., of Sandusky, O., has agreed to undertake the preparation of this sand, and to furnish it at a price only sufficient to cover the actual cost of preparation.

While the form of the briquette recommended by a former committee of the society is not wholly satisfactory, this committee is not prepared to suggest any change, other than rounding off the corners by curves of ½-in. radius, Fig. 3.

MOLDS.

The molds should be made of brass, bronze or some equally non-corrodible material, having sufficient metal in the sides to prevent spreading during molding. Gang molds, which permit molding a number of briquettes at one time, are preferred by many to single molds; since the greater quantity of mortar that can be mixed tends to produce greater uniformity in the results. The type shown in Fig. 4 is recommended. The molds should be wiped with an oily cloth before using.

MIXING.

All proportions should be stated by weight; the quantity of water to be used should be stated as a percentage of the dry material. The metric system is recommended because of the convenient relation of the gram and the cubic centimeter. The temperature of the room and the mixing water should be as near 21° C. (70° F.) as it is practicable to maintain it. The sand and cement should be thoroughly mixed dry. The mixing should be done on some non-absorbing surface, preferably plate glass. If the mixing must be done on an absorbing surface it should be thoroughly dampened prior to use. The quantity of material to be mixed at one time depends on the number of test pieces to be made; about 1,000 gr. (35.28 oz.) makes a convenient quantity to mix, especially by hand methods.

The committee, after investigation of the various me-

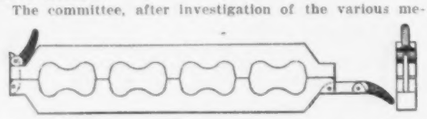

Fig. 4. Recommended Form of Gang Molds for Making Cement Briquettes.

chanical mixing machines, has decided not to recommend any machine that has thus far been devised, for the following reasons: (1) The tendency of most cement is to "ball up" in the machine, thereby preventing the working of it into a homogeneous paste; (2) there are no means of ascertaining when the mixing is complete without stopping the machine, and (3) the difficulty of keeping the machine clean.

METHOD.—The material is weighed and placed on the mixing table, and a crater formed in the center, into which the proper percentage of clean water is poured; the material on the outer edge is turned into the crater by the aid of a trowel. As soon as the water has been absorbed, which should not require more than one minute, the operation is completed by vigorously kneading with the hands for an additional 1½ minutes, the process being similar to that used in kneading dough. A sand-glass affords a convenient guide for the time of kneading. During the operation of mixing the hands should be protected by gloves, preferably of rubber.

MOLDING.

Having worked the paste or mortar to the proper consistency, it is at once placed in the molds by hand. The committee has been unable to secure satisfactory results with the present molding machines; the operation of machine molding is very slow, and the present types permit of molding but one briquette at a time, and are not practicable with the pastes or mortars herein recommended.

METHOD.—The molds should be filled at once, the material pressed in firmly with the fingers and smoothed off with a trowel without ramming; the material should be heaped up on the upper surface of the mold, and, in smoothing off, the trowel should be drawn over the mold in such a manner as to exert a moderate pressure on the excess material. The mold should be turned over and the operation repeated. A check upon the uniformity of the mixing and molding is afforded by weighing the briquettes just prior to immersion, or upon removal from the moist closet. Briquettes which vary in weight more than 3% from the average should not be tested.

STORAGE OF THE TEST PIECES.

During the first 24 hours after molding, the test pieces should be kept in moist air to prevent them from drying out. A moist closet or chamber is so easily devised that the use of the damp cloth should be abandoned if possible. Covering the test pieces with a damp cloth is objectionable, as commonly used, because the cloth may dry out unequally, and, in consequence, all the test pieces are not maintained under the same condition. Where a moist closet is not available a cloth may be used and kept uniformly wet by immersing the ends in water. It should be kept from direct contact with the test pieces by means of a wire screen or some similar arrangement.

A moist closet consists of a soapstone or slate box, or a metal-lined wooden box—the metal lining being covered with felt and this felt kept wet. The bottom of the box is so constructed as to hold water, the sides are provided with cleats for holding glass shelves on which to place the briquettes. Care should be taken to keep the air in the closet uniformly moist.

After 24 hours in moist air, the test pieces for longer periods of time should be immersed in water maintained as near 21° C. (70° F.) as practicable; they may be stored in tanks or pans, which should be of non-corrodible material.

TENSILE STRENGTH.

The tests may be made on any standard machine. A solid metal clip, as shown in Fig. 5, is recommended; this clip is to be used without cushioning at the points of contact with the test specimen. The bearing at each point of contact should be ¼-in. wide, and the distance between the center of contact on the same clip should be 1¼ ins.

Test pieces should be broken as soon as they are removed from the water. Care should be observed in centering the briquettes in the testing machine, as cross-strains, produced by improper centering, tend to lower the breaking strength; the load should not be applied too suddenly, as it may produce vibration, the shock from which often breaks the briquette before the ultimate strength is reached. Care must be taken that the clips and the sides of the briquette be clean and free from grains of sand or dirt, which would prevent a good bearing. The load should be applied at the rate of 600 lbs. per minute. The average of the briquettes of each sample tested should be taken as the test, excluding any results which are manifestly faulty.

CONSTANCY OF VOLUME.

SIGNIFICANCE.—The object is to develop those qualities which tend to destroy the strength and durability of a cement. As it is highly essential to determine such qualities at once, tests of this character are for the most part made in a very short time, and are known, therefore, as accelerated tests. Failure is revealed by cracking, checking, swelling or disintegration, or all of these phenomena. A cement which remains perfectly sound is said to be of constant volume.

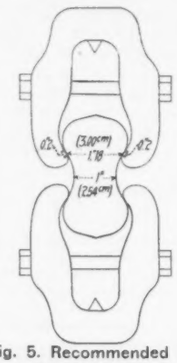

Fig. 5. Recommended Form of Clip for Cement Briquettes.

METHODS.—Tests for constancy of volume are divided into two classes: (1) normal tests, or those made in either air or water maintained at about 21° C. (70° F.), and (2) accelerated tests, or those made in air, steam or water at a temperature of 45° C. (115° F.) and upward. The test pieces should be allowed to remain 24 hours in moist air before immersion in water or steam. For these tests, a pat, about 7½ cm. (2.95 ins.) in diameter, 1¼ cm. (0.49-in.) thick at the center, and tapering to a thin edge, should be made, upon a clean glass plate [about 10 cm. (3.94 ins.) square], from cement paste of normal consistency.

NORMAL TEST.—A pat is immersed in water maintained as near 21° C. (70° F.) as possible for 28 days, and observed at intervals; the pat should remain firm and hard and show no signs of cracking, distortion or disintegration.

ACCELERATED TEST.—(a) A pat is placed on a shelf in a suitable vessel filled with fresh water, but without allowing it to touch the bottom. The water is then gradually raised to a temperature of 45° C. (115° F.) and maintained at this temperature for 24 hours; or (b), a pat is exposed in any convenient way in an atmosphere of steam, above boiling water, in a loosely closed vessel, for three hours.

To pass these tests satisfactorily the pats should remain firm and hard and show no signs of cracking, distortion or disintegration. Should the pat leave the plate, distortion may be detected best with a straight-edge applied to the surface which was in contact with the plate. In the present state of our knowledge it cannot be said that cement should necessarily be condemned simply for failure to pass the accelerated tests; nor can a cement be considered entirely satisfactory simply because it has passed these tests.

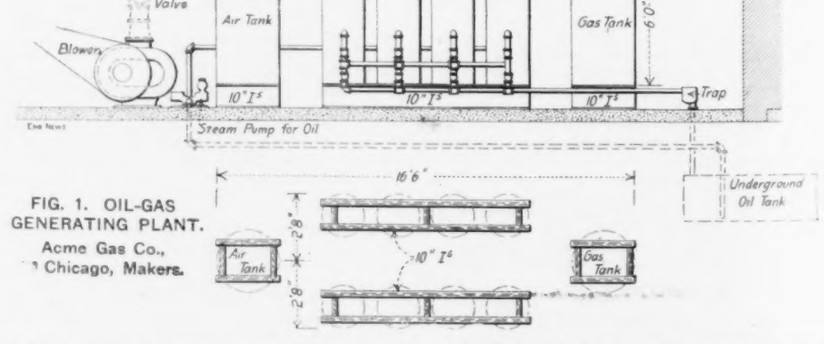

FIG. 1. OIL-GAS GENERATING PLANT.
Acme Gas Co., Chicago, Makers.

Submitted on behalf of the committee: George S Webster, Chairman; Richard L. Humphrey, Secretary; George F. Swain, Alfred Noble, Louis C. Sabin, S. B. Newberry, Clifford Richardson, W. B. W. Howe, F. H Lewis.

AN OIL-GAS SYSTEM FOR ISOLATED PLANTS.

The high price and scarcity of coal during the past six months has given a boom to the promoters of substitute fuel processes, good, bad and in-

different—mostly bad. Only a few days ago one of the most conservative of the New York daily papers printed an item announcing the invention of a new, cheap fuel, which was expected to revolutionize industry. A particular merit was its cheapness, as its principal ingredients were clay and sand!

One particular type of new fuel process which appears to be in special favor with promoters is what is known among gas engineers as the "greased air process." Briefly described, this process consists in blowing air through some petroleum product. Under proper conditions it is possible to make a very fair combustible in this way, and gas machines of this type furnishing gas for illuminating isolated country houses have been in use for many years. There is, therefore, nothing radically novel or revolutionary in the process, but the dangers in connection with it and various uncertainties in its operation have tended to discourage its use.

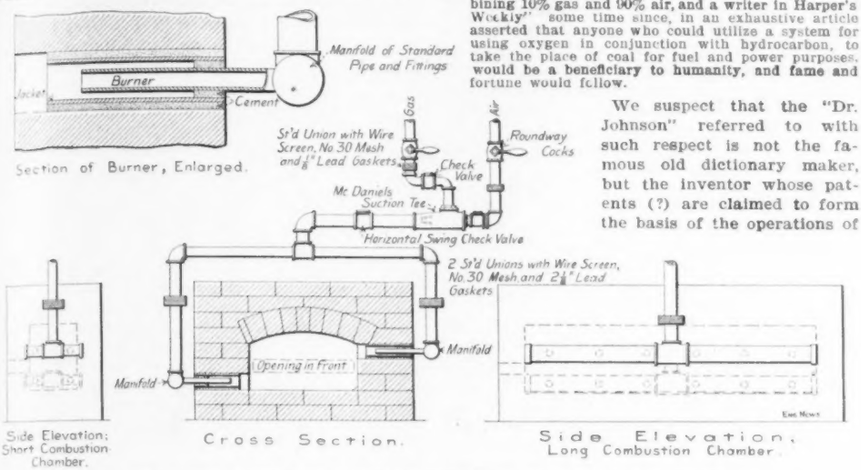

FIG. 2. BURNER AND FURNACE FOR THE ACME OIL-GAS SYSTEM.

Over two years ago, in our issue of Oct. 11, 1900, we reviewed the prospectus of one of these "greased air process" concerns, the American Heat, Light & Power Co., of Boston. We recently came across a new prospectus of this company; and it is interesting to compare it with its announcement of two years ago. We notice in the first place that it has moved to New York city; its capital is now $6,000,000, whereas it was only $1,000,000 before. Truly these be expansive times in which we live! The process is the same old process. The same old gag is inserted about "combustible oxygen,"—using the oxygen of the air as a fuel. Not only this, but the same old slip—or a new one of the same sort is enclosed with the prospectus, urging investors to remit at once because, forsooth, the price of the stock is shortly to be advanced! Two years ago the slip said:

> Nearly all the stock of the American Heat, Light & Power Co. is subscribed. If you care to look into the merits of this extremely promising investment, please call or open correspondence immediately, as I believe that the opportunity will not remain open many days.

The slip in the current prospectus says:

> The heavy demand for shares in the American Heat, Light & Power Company indicates that the entire allotment of shares for sale at 40 cts., may be exhausted this week. It is announced, positively, that the price advances at the close of business, Nov. 22, to 50 cts.—then rapidly to par.

Now, according to the company's own statement two years ago, "Nearly all the stock was subscribed."—and the capitalization then was $1,000,000! A very natural question is what the company managers have done with the large amount of working capital, which, by their own statement was subscribed two years ago. Until this query is answered we shall be obliged to regard the present "heavy demand for shares" with a mild degree of skepticism.

Perhaps we should apologize to our readers for taking space to expose so transparent a scheme; but as this concern has been recently advertising its stock in reputable New York daily papers and using the name of the Massachusetts Institute of Technology in these advertisements, we deemed it proper to give it a free advertisement ourselves.

While we are on the subject, we may note that when the concern moved to New York it appears to have left a successor at Boston. A correspondent sends us a clipping from the Boston "Herald" of Nov. 23 containing an advertisement of the "Airified Gas Heating & Power Co.," from which we quote as follows:

> Dr. Johnson long ago asserted the practicability of combining 10% gas and 90% air, and a writer in Harper's Weekly" some time since, in an exhaustive article asserted that anyone who could utilize a system for using oxygen in conjunction with hydrocarbon, to take the place of coal for fuel and power purposes, would be a beneficiary to humanity, and fame and fortune would follow.

We suspect that the "Dr. Johnson" referred to with such respect is not the famous old dictionary maker, but the inventor whose patents (?) are claimed to form the basis of the operations of the American Heat, Light & Power Co. Further on in the ad. we strike something else which sounds familiar:

> The earning power of the stock of the Airified Gas Heating & Power Co. will be something extraordinary. The influx of orders for stock at the organization price of 50 cts. per share shows how interested the public are in the subject. Remember, as soon as this first allotment, 10,000 shares, is disposed of, the price will be advanced to par, $1 per share.

As for the "10% gas and 90% air," our correspondent who sends us the above suggests:

> Let us now organize a company to produce and sell at 1 ct. per quart, Aquafied Milk, formed in a mysterious way by combining 10% of milk with 90% oxide of hydrogen, commercially known as water!

So much for the operations of these two "greased wind" concerns. We now desire to show that it is quite possible to make a very respectable fuel gas by this general process, and that this probably explains the success of these concerns with their exhibition plants.

For some time a company in Chicago, known as the Acme Gas Co., has been doing a legitimate business in installing fuel gas systems in which heated air is forced through oil, and it has furnished to us blue prints from which the accompanying illustration of its apparatus are made. The oil used is a "crude distillate of petroleum," by which we presume is meant an oil distilled from crude petroleum, having a wider range of vaporization than kerosene. The process of manufacture consists in forcing warm air through oil contained in a series of small tanks.

The general arrangement of a plant having a capacity of 20,000 cu. ft. of gas per hour is shown in Fig. 1. The oil is fed from a small tank into the generators by a pump, and is kept in continuous circulation through the tank and generators. The object of this is said to be to ensure a uniform quality of gas and to utilize the oil as completely as possible. The small supply tank (usually underground) contains a supply for one day only, and is shut off from the main oil storage tank except when being filled. The air from the blower is delivered to a 30-in. air tank, containing a steam-heating coil. From this it passes to two groups of 20-in. generators, each group consisting of four tanks. The oil fills only about 25 to 30% of the tanks and the small pipe near the bottom is for the circulating system and to maintain a uniform level. The air pipe is led below the surface of the oil, and horizontal perforated plates keep the oil from rising or blowing. The gaseous mixture of air and oil escapes from the top of the tank and is piped to the bottom of the next tank, and so on throughout the series. Beyond the generators is a gas tank or reservoir 30 ins. diameter, from which the supply is piped to the furnaces, etc.

Fig. 2 shows the general construction of the furnace and burner. The form and dimensions of the furnace and the number of burners used vary with the character of the work to be done. Wire screens are inserted at different parts of the piping, as shown, to prevent any possibility of the flame being blown back through the pipes. The burner is a simple pipe nozzle, inserted in a chamber which is fitted with a pipe jacket built into the wall, so that the burner can be taken out and renewed without tearing down the wall. A cement packing is filled between the burner and jacket. Combustion takes place just beyond the chamber. The two burners arranged as shown form a rotating flame of great heat which fills the furnace, and bars or other pieces to be heated are inserted through the opening shown by dotted lines. Fig. 3 is a view of a furnace of this kind, but has the long slot replaced by four rectangular openings.

The generating plant is automatic in action, the production varying in accordance with the demand, and the plant is said to require no attention when in operation. The gas is manufactured only as fast as it is required, so that no gas holder is required for storage.

The Acme fuel gas plants have been used for about three years in some of the United States navy yards, for forging, welding and heating in connection with the manufacture of guns, anchors and chains for warships. It is also used by the Deering Harvester Works, of Chicago, in three tempering furnaces. The Modern Steel Structural Co., of Waukesha, Wis., is using it in 10 furnaces for heating rivet rods and rivets, and for running a 50-HP. gas engine, as mentioned in the description of this plant in our issue of Aug. 7. There is a large plant at the works of the Kingman Plow Co., Peoria, Ill., where the gas is used in 24 heating and welding furnaces. The Streator Bottle & Glass Co., of Streator, Ill., is using the gas for heating its bottle molds. The R. Herschel Mfg. Co., of Peoria, Ill., is using it for two furnaces for hardening mower sections, for lead pots for dipping, and for the temper-drawing furnace. The Milwaukee Wagon & Iron Works uses the gas in 12 furnaces for heating and welding, and reports that with the use of the gas plant the output of the shop has been largely increased, with a less number of men employed, while the work is done with a much better finish and quality of welding.

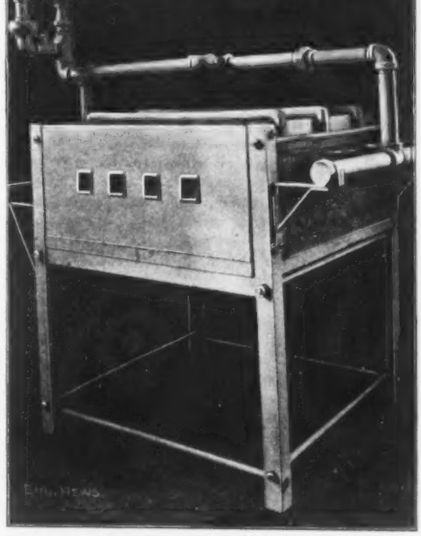

Fig. 3. Acme Oil-Gas Furnace for the Parsons Band Cutter and Self-Feeder Co., Newton, Ia.

We have made inquiries in regard to the opera-

tion of this system at several plants, and we give below a summary of the replies:

1. The grade of oil used is given in all cases as a crude distillate of petroleum of about 68° to 70° gravity; while one firm has also used 68° stove gasoline.

2. As to residuum of oil in the generators, one firm mixes it with the ordinary fuel oil; three have as yet no use for it, and four report no residuum.

3. As to the efficiency of the gas and of the process, seven out of ten replies are favorable. In two cases it effected a saving of 50 and 75% as compared with city gas formerly used. The latter saving was in the use of gas for hardening purposes; where it formerly cost $1 for city gas, the same work is done by Acme gas costing only 25 cts. The efficiency of the gas in this case is due to the pressure under which it is burned and also to its purity, giving better results than the city gas. One of the unfavorable replies states that the system is not as yet considered efficient; it is now used only in the gas stoves, where it is found satisfactory. Another reply states that while the gas will work in heating furnaces its value for blacksmith forge work has not yet been demonstrated, and that so far the process has not been found economical. The company sending the third reply states that at present it cannot recommend the system.

We are informed that the Acme apparatus is made under patents granted to R. M. Bidelman in 1892 with others of later date. The office of the Acme Gas Co. is at 1010 Monadnock Block, and Mr. N. W. Harvey is the President.

It will be apparent from the above account that it is quite possible to make at least a satisfactory working demonstration of a "greased air" process of gas manufacture, and further that any concern claiming an exclusive right to this process should be regarded with extreme suspicion.

AN UNUSUAL CASE OF DEATH FROM ELECTRIC SHOCK.

The low potential at which electric incandescent lamp circuits are operated is generally supposed to be entirely incapable of causing the death or serious injury of persons coming in contact with it. An accident which recently occurred in England shows that under favorable circumstances death may be caused by such electric currents as are in common use on house circuits.

The accident was the subject of an official investigation, a verbatim report of which is printed in the London "Electrician," and from it we glean the following particulars:

The scene of the accident was the public bath establishment of the borough of Fulham, London. The place contains individual bath cabinets separated from each other and from a corridor by low screen partitions of slate. Along the top of the slate panels there runs a capping bar of galvanized iron, which frames the panels together; there is no vertical metal framing, the panels being set in the floor concrete and tied together at the corners by occasional angle clamps. The place was lighted by electricity. The wires were enclosed in insulated metal pipes which ran part way along the top of the partition between each two baths, and ended there in a metal saddle having two lamp sockets, one for each cabinet.

At times when the water supplied to the baths was not warm enough, bathers were in the habit of stepping up on the tubs so that they could look over the partition into the corridor and call to the attendant. On Dec. 23, 1902, a bather about to call for warm water in this manner took hold of the top edge of the partition with its metal capping bar; in doing so he received a strong electric shock. He was able to cry out and say something about electricity, whereupon the attendant at once ran to the fuseboard of the lighting circuit and pulled out the fuses. When the current was thus interrupted the bather in question fell to the floor, and when raised up he was dead.

About an hour later a bather in another of the bath cabinets was found on the floor, dead. Rigor mortis had already set in, and it is thought that at the cry of the first victim he also took hold of the top of the partition so as to look over into the corridor, and was killed in the same manner as the other. An autopsy indicated that death in both cases resulted from electricity and not from the fall. At the coroner's inquest a number of other persons who were bathing in this establishment at the time testified that when the first victim cried out they attempted to climb up to look over the partition to see what was the matter, and in each case received a shock, severe enough in the case of some to throw them to the floor.

Testimony showed that the pipes containing the electric wires did not make continuous metallic connection, the sections of pipe being insulated from each other at the joints and at the (wooden) fuse-boxes. The pipes were not earthed, or at least only a few sections had ground connection. It was found that the saddles containing the lamp sockets, at the top of the partitions between the bath cabinets, were loose enough to be easily shaken by the hand; it was also found that there was leakage of current here between the saddles and the wires supplying the lamps. As there was no vertical partition framing the capping bar was not earthed, and it was therefore charged with electricity from the wires, being in metallic connection with the saddles. The potential supplied to the lamps was 205 volts, alternating. Measurement after the accident showed that there was a pressure of 165 volts from the capping bar to earth.

It was further brought out at the inquest that the architects' specification explicitly called for the style of construction involving the metal lamp fittings mounted on the metal capping bar, the insulated metal pipe conduits for the wires and insulating connections between the different sections of the pipe. The rules of the Phoenix Fire Office were referred to as governing the installation, and these call for earthing of the pipe conduit. However, in putting in the wiring this earthing was omitted, with a view to minimizing the leakage losses. Wooden fuse boxes were specified and were used.

The coroner charged the jury that the first victim did an unnecessary thing in attempting to look over the partition so as to call for water, but that this did not hold in the case of the other victim. The jury, if they so found proper, might charge some one with blame for the accident. The jury found the following verdict:

> Death is due to syncope caused by electric shock owing to faulty design and construction of the electric installation, but we are unable to say on whom the blame rests.

The coroner interpreted the verdict to mean that death was accidental.

A NEGLECTED POINT IN THE THEORY OF CONCRETE-STEEL.

By John Stephen Sewell.*

Apropos of the increasing use of reinforced concrete, and recent additions to the theory of its action under strain, it seems to the writer that there is one very important part of the theory that has not been worked out by any American investigator. Prof. Hatt's† treatment of conditions existing at the middle of the span in a reinforced concrete beam leaves little to be desired, and any errors it may contain are well within the unavoidable variations in actual construction. It is merely a question of determining a proper working value of the modulus of elasticity for each kind of concrete; then the assumption that the stress-strain curve in the compression flange is a parabola, and that all the tensile stress is borne by the steel reinforcement seems to be a safe and economical working basis for actual design, and just as accurate as the nature of the material calls for.

But this applies only to the middle of the span. Near the points of support there are also internal stresses and here they are no longer horizontal, but vary from this direction to one at right angles thereto. A diagram showing the lines of tension and compression in a loaded beam makes this clear. Fig. 1 shows such a diagram for a beam overhanging one of its supports. A similar diagram for a simple beam resting on two points of support is to be found in Rankine's "Mechanics," p. 342. In the diagram shown, the broken lines give the direction of the principal tensile stress at any point, and the full lines that of the compressive stress, in a beam supported as shown and subjected to cross bending. These are, of course, principal stresses, without lateral components; and while in ordinary practice, we resolve stresses into vertical shear and horizontal fiber stress, this assumption does not prevent‡ the actual existence of the principal stresses, with directions tangent to the lines shown. In steel and timber girders,

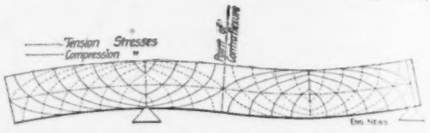

Fig. 1. Lines of Principal Stress in a Beam Overhanging One Support.

the nature of the materials is such that if shear and horizontal fiber stress are provided for, the principal stresses will require no attention. But when it becomes necessary to use a material of such low tensile strength as concrete, this by no means holds good. The actual stresses in a beam or structure may be resolved into any set of components and means provided for resisting each; but if there remains a possibility of resolution into any other set for which no provision is made, the stresses will seek relief by the path of least resistance, and failure may easily result.

Thus, a concrete beam may, by virtue of horizontal steel reinforcement and the compressive strength of the concrete, be safe against both actual vertical shear, and horizontal fiber stress; but the principal stresses will exist as such for all that, and failure may still result even though the reinforcement has been designed according to the best formulas. In concrete, it will be the principal tensile stress that will give trouble. If failure occurs under it, the ruptured section will be near the points of support, and tangent to the curves of compression. The amount of this tensile stress at any point will never be less than the shear at the same point, and, near the supports, this may be very considerable. In the case of the reinforced concrete beam, it may reach the ultimate strength of the concrete, especially under impacts and vibrations. Moreover, the normal adhesion of cement to steel is much less than the tensile strength of the cement or of the concrete made from it (see Eng. News, Oct. 2, 1902, pp. 261-2). The internal tensile stress will have a considerable vertical component at any point near the ends of a span. Under this sort of strain, because of the small value of the normal adhesion, the horizontal steel reinforcement is a source of weakness, instead of strength.

This is almost undoubtedly the true explanation

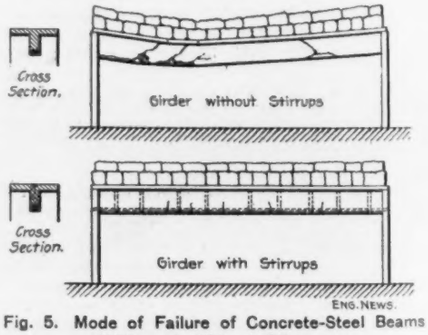

Fig. 5. Mode of Failure of Concrete-Steel Beams With and Without Stirrups.

of most of those cases that have occurred in practice, where the steel has seemed to slip in the concrete. The skin friction is about 500 lbs. per sq. in.; the normal adhesion is probably not over 50. It is absurd to suppose that any ordinary impact or vibration could so increase the tension in the steel as to overcome the skin friction; the steel would part first. With the normal adhesion, however, the matter is quite different; it is probably very near failure under the ordinary static load;

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†See Eng. News of Feb. 27, 1902, for an article entitled "Theory of the Strength of Beams of Reinforced Concrete," by Prof. W. K. Hatt.

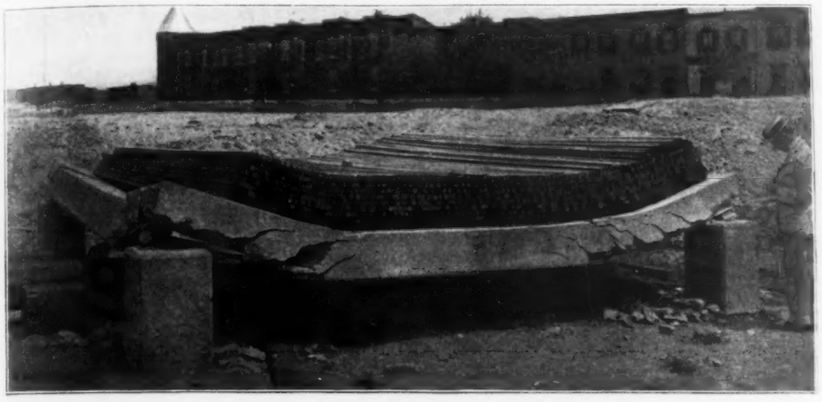
‡In solid beams, at any rate.

a slight increase from any cause will induce failure, with rupture along planes tangent to the compression curves, generally at about the 45° point.

This trouble will not be cured by twisting, corrugations, or any other inequality of surface in the steel bars or other reinforcement. The only remedy is to reinforce the concrete against all internal tensile stresses, whether horizontal or otherwise.

The necessity for this seems to have been overlooked in this country, at any rate, until very recently. In Europe it has been recognized and provided for by bending some of the steel reinforcing members so as to approximate the form of the curves of tension, and by inserting vertical or inclined stirrups, usually passing around the outermost steel members and binding them to the mass of concrete within. The point is: if these stirrups and other reinforcing members that make an angle with the horizontal are necessary, there must be some rational method of determining their proper sizes and locations. So far as the writer is aware, no one has ever offered any analysis of this problem. The European engineers and contractors have used stirrups with great success; but their methods of design seem to be purely empirical.

One needs only to go back to Rankine, or any equivalent treatise, to find that sound theory points at once to the probable necessity for vertical reinforcement near the points of support of a concrete-steel beam, and for years experience with actual failures has pointed plainly in the same direction. But it remained apparently for a practical man, without technical training, to do what engineers should have done from the beginning. This man saw that concrete-steel beams often failed "under shear" as it would commonly be expressed, producing rupture along surfaces tangent to the internal lines of compression and inclined at about 45° to the horizontal. Without worrying about the nature of the internal stresses, he probably reasoned that steel stirrups inserted so as to traverse the surfaces of rupture would cure the trouble, and he was right. That, however, is no reason why the subject should not be submitted to analysis and a proper working theory formulated, if possible; for while the beams with the stirrups in them can be made to fail in the middle rather than at the ends, there is no means of knowing when all parts of the design are so proportioned as to give the same factor of safety throughout. Probably a good many experiments would be needed as a preliminary to the final analysis, but it seems to the writer that this is a promising field for investigation for graduation theses, unless some mature investigator will take the subject up and finish it, once for all.



FIGS. 2, 3, 4. VIEWS OF TWO BAYS OF CONCRETE-STEEL FLOOR AFTER TEST TO FAILURE. FLOORS REINFORCED WITH RANSOME TWISTED STEEL BARS, WITHOUT STIRRUPS.

To show that failure takes place as indicated, the accompanying views, Figs. 2, 3 and 4, photographs of an actual test, are submitted. The writer has seen many beams constructed on the same system in actual work, exhibiting incipient failure in exactly the same way as total failure is shown in these views. There is also submitted Fig. 5, a drawing, copied from the catalogue of a company which exploits a system of stirrups and bent rods, showing the results of comparing a beam reinforced with stirrups, and one not so reinforced. While this is not a photographic record, there is no reason to doubt that it represents, in all essential particulars, the relative behavior of two such beams. The beam without stirrups fails by "shearing" near the ends before the full strength of the section at the center is developed. The other beam, reinforced vertically by stirrups, can have its load increased until failure takes place at the center of the span.

An interesting test of Ransome concrete-steel floors is reported in Engineering News of Dec. 25, 1902. The floors tested were molded in floor-slabs and deeper supporting beams; the latter were reinforced with stirrups in addition to the longitudinal rods. However, the stirrups were evidently not sufficiently numerous and not close enough together to prevent failure by shearing, though they manifestly increased the resistance in this respect.

The stirrups next to the ends of the span were within a distance from the points of support less than the depth of the beams. Consequently, no shear occurred between them and the points of support. The interval between them and the stirrups towards the center of the span, however, was about twice as great as the depth of the beams, and failure by shear began in this interval. These tests indicate very strongly what theory and previous tests point to, namely, that the stirrups, however proportioned as to size, should be separated by intervals a little less than the depth of the beam. They should also be continued practically to the middle of the span, and near the ends, the intervals between them should be made very much less than the depth of the beam.

At the present time, European practice is far ahead of American in the use of reinforced concrete. Yet the underlying principle of entire success is merely this: the concrete should be reinforced against all tensile stresses, whatever their location and direction. If this is done accurately, steel frames for buildings will no longer be needed, and there will result a type of building stronger, cheaper, more thoroughly fireproof, and more enduring than any the world has ever seen. It requires but a finishing touch to round out the correct theory; may this much, at least, be accomplished on this side of the Atlantic! And while American architects and engineers have been slow to begin, may it fall to their lot to perfect that application of what seems, at last, an ideal material for buildings and other important structures!

THE REMOVAL OF A STEEL FRAME BUILDING.

The demolition of a steel-frame building in New York city gives an opportunity to note the effect of time on structural steel work. The Pabst Hotel, an eight-story structure erected in 1898 at the corner of Broadway and Forty-second st., is being removed to make way for a larger building. The hotel stands on a small triangular lot bounded by Broadway, 7th Ave. and 42d St., and is partly over the location of the four-track subway of the New York Rapid Transit Railway (see Eng. News of Oct. 2, 1902). The line is to have a station at this point, and the hotel building was not well suited to the general scheme of the subway work.

The building is only about 30 by 60 ft. in ground plan, which is trapezoidal to fit the shape of the lot. Quite recently the Subway Realty Co., a corporation allied to the companies which have been formed for constructing and operating the Rapid Transit Railway, acquired the hotel building and the lot upon which it stands, with the object of replacing the hotel by a larger building which will also contain the station rooms.

At present the first part of the work, the removal of the hotel building, is in progress. The terra cotta and cut stone portions of the front walls, and the entire steel framework, are to be used for re-erecting the building on another site farther uptown. The framework consists of steel Z-bar columns, and steel floor beams and girders with riveted connections. The walls are of brick laid up in cement mortar. The floors are Roebling arches made of cinder concrete erected on stiffened wire-mesh centers. The interior partitions are single-thick, made of a sheet of expanded metal plastered on both sides to give a finished thickness of about two inches. In demolishing the building, the partitions are torn out, the floors are broken through and cut, and the steelwork and the outside walls taken down; floors, walls and steelwork are worked not more than a story apart. The field rivets of the steelwork are cut by hand, using set-chisel and sledge. The walls are broken up with cold chisels; the cement mortar being very hard and strong, there is no salvage on the brick.

The entire structural part of the building is in excellent condition, in fact it seems fully as good as in a newly-erected building. Of greatest interest is the condition of the steelwork. This is excellent throughout, in the columns as well as in the beams; the surfaces still show the original adherent coat of black (Nobrac) paint, and there is no indication of deterioration by corrosion. In the beam-work there are some spots, mainly on the upper flanges, where there is a slight coat of rust; this is evidently due to the paint having worn off at the time of erection, so that a little rusting occurred at that time, but the rusting apparently did not progress.

The beams and girders were practically everywhere encased in the concrete; this was the cinder-concrete of the floor arches, and this fact should be specially noted in view of a somewhat prevalent view that cinder-concrete, especially when placed so as to have a porous and open texture, is favorable to corrosion of the steel with which it is in contact. The nature of the concrete in the floor arches of this building is referred to below. The columns were not encased like the beams in concrete, but were surrounded by tile fireproofing, which left a slight air space immediately surrounding the steel. The columns are in practically perfect condition, as noted above.

The wire-mesh of the floor arch centers (as used in the Roebling floor system) and in the suspended ceilings show a fair surface coat of rust, but not more than would probably form while the concrete and plaster were wet. In the arch centers, as well as in the ceiling, the wire-mesh is not completely encased in the system of construction used here, but has practically half its surface exposed to air. This undoubtedly constitutes a condition favorable to rusting before the original moisture in the floor and ceiling material disappears. The expanded metal of the partitions is in about the same condition in respect to rust as the wire-mesh.

The nature of the floor concrete is of interest in connection with the matter of the condition of the steelwork. It was made and placed in the manner regularly practiced for the construction of floors of this particular system. The proportion of cement to cinders is smaller than is ordinarily used for concrete, and the mixture is then simply thrown from shovels, without ramming, on to the wire-mesh centering and allowed to set. The ramming is omitted with the object of securing a very porous concrete, and an important advantage claimed for the material so produced is that it may be put in place during freezing weather without harm, as the porous condition of the concrete enables it to withstand, without cracking, the expansion due to freezing of the contained water. As a matter of fact, much of the floor concrete in this building was put in place during freezing weather, we are informed. We were interested, therefore, to note that the concrete removed from the floors is remarkably hard and strong, and while it is doubtless quite porous, a fractured face shows a solid and firm surface.

PROGRESS IN ENGINEERING EDUCATION.*

By Wm. D. Pence, M. Am. Soc. C. E.†

Technical education had made progress in the United States before the general government made provision for the endowment of technical schools in the several states and territories. After the endowment was provided, the land grant colleges were organized in rapid succession, and in a very few years the graduates of these and similar institutions endowed privately began to make themselves felt in the more responsible places of the engineering professions. In this wise there has been evolved in the course of a quarter of a century a group of engineering schools which have assumed a place of the utmost importance when we measure their influence upon the industrial progress of the country and in upbuilding the status of engineering as a learned profession.

From the start there was much in common in the work of the various engineering schools, but no concerted action was taken until 1893 when in connection with the Engineering Congress at Chicago there was organized the "Society for the Promotion of Engineering Education." Its membership at present includes nearly 300 representatives from the faculties of more than 80 institutions, and about 30 members are practicing engineers who feel a special interest in technical education. Another important organization having a similar object is the Association of Presidents of Land Grant Colleges.

In tracing the progress of engineering education, we may consider the subject with respect to the following divisions: 1, Growth of attendance; 2, The student at entrance; and, 3, The standard of instructional work.

GROWTH IN ATTENDANCE.

From the very striking increase in attendance of students, especially within the past five years, we must conclude that there is a growing appreciation of technical education. Statistics collected by the Society for the Promotion of Engineering Education (Proceedings, Vol. X., pp. 231-57) showed that during the school year 1901-1902, there were 15,000 engineering students in attendance at the 114 institutions in the United States which have courses in engineering. Allowing for possible omissions and for the increase since last year, it seems a safe estimate that there are now something like 16,000 engineering students in attendance at the schools of this country. The engineering courses presented have an exceedingly wide range, including civil, mechanical, electrical, municipal, sanitary, mining, metallurgical, chemical and architectural engineering, architecture, naval architecture, and a few other related courses.

In view of the intimate relation of the technical school with the industrial world it is to be expected that the ups and downs of the business outside the college walls will find a definite response in the rate of growth of students' enrollment; and such is the case. A sympathetic pulsation of this kind is shown by a diagram of annual attendance of various institutions

It is a matter of interest that the dip of the attendance curve seems to lag two or three years after the low wave of business. This phenomenon is possibly due to the fact that the tightened purse-string at home often prevents the entry of the new student, but sacrifices are likely to be made to enable the upper class student to complete his course.

Public appreciation of the engineering school system is steadily growing. Notwithstanding disturbing influences, the popular movement seems certain to grow in favor, on the one hand, with those who employ technically trained help, and on the other with the serving class itself. It is an interesting, and indeed considering the enormous output of our technical schools, an astonishing fact as well, that the demand for graduates is quite in excess of the supply at the present time. A still more startling and gratifying illustration of the popular movement towards self improvement is to be seen in the enormous growth of the correspondence school patronage. One of the best of these institutions has passed the incredible figure of 500,000 students. Admitting that work done in absence by inexperienced students is not likely to be of the highest grade, it must nevertheless be conceded that this movement among the masses who as a rule cannot afford the more desirable and technical course is bound to have a far-reaching influence.

THE STUDENT.

There has been a gradual improvement in the preparation of the student for entrance to the technical school. The preparatory schools have raised their standard by adding branches and improving their equipment and teaching methods. In the West, each state has its commissioned or accredited high schools, the graduates from which are usually admitted to the state and other engineering schools without further examination. Elsewhere there has been a tendency with certain institutions to raise their admission requirements abnormally high, the difference between the two extremes of practice in this regard being equal to about one full collegiate year. There is much to be said in favor of keeping the entrance requirements reasonably within the reach of the masses. It is almost axiomatic that thoroughness of preparation in a few fundamentals is of much greater value than a superficial training in a large number of subjects.

A technical school which draws its students from an engineering environment has a distinct advantage over one whose students are in reality a raw material as regards their lack of contact with engineering work before entering college. It is a fact, however, that the disadvantages that some schools are laboring under in this regard is pretty largely outweighed by the students securing vacation employment. For example, in one school where perhaps less than 10% of the students entering the course in civil engineering had had the environment just referred to, about 40 out of a total class of 60 students, secured vacation employment at the end of their second or sophomore year, at pay ranging from $40 to $60 (a few still higher). This was chiefly in railway location, construction and maintenance, on many roads, in widely separated portions of the country; but also in other lines of work, such as city engineering, contracting, etc. The immediate effect of this schooling outside was of much importance; the results accomplished in the following year's work in school in field and office work showed a distinct improvement both in quantity and quality.

The advantages thus derived from contact with engineering work for the brief vacation period suggests the question of a possible further gain by the plan of having the years of outside practice alternate with years of college work. This plan is often followed by young men who are making their own way, and there are obvious merits in it, provided the habits of being studious are maintained in the "off years" which usually is not done. The student must have more than average grit and steadfastness in his makeup if he makes an entire success of this alternation plan; and there is the further danger that once out of school he will not see his way clear to return again.

THE INSTRUCTIONAL WORK.

The engineering schools are not pretending to turn out graduates who are engineers. It would be absurd to attempt such a feat in the four short years that are usually given to the engineering courses. In truth the period is devoted to establishing the foundation of the structure. Our engineering schools usually lean towards the theoretical side, and it is against this tendency that most of the criticisms by practicing engineers are directed. The real question is: "How far shall the engineering school go in an attempt to teach engineering as an art rather than as a science?" After reading a miscellaneous series of criticisms of the work of the engineering school it would seem that the attack may be expressed in a single sentence: "Teach more things and teach everything better." But the late venerable engineering educator, De Volson Wood, a few years prior to his death, told a friend that if he were privileged to live his life as a teacher over again, in the light of his ripe experience, he would "teach fewer things, and try to teach them better." Possibly this view was tinctured with the conservatism of advancing years, but the spirit of it is bound to appeal to anyone who has had much experience with the problem of trying to teach as much as possible of the fundamentals of some important subject in the brief time allotted to it in the college schedule.

Engineering schools have their peculiarities; one institution is perhaps extremely theoretical, while another goes to the opposite extreme; one has elaborate shops, another has none; one makes much of laboratory practice, another of its drafting and design work; another is well balanced in all lines, and so on. But on the other hand, there is much that the schools have in common; and nothing is more certain than that all are seeking to do the best within their power to assist the young men who come to them to attain to the highest possible standard in their subsequent professional life. And at most of the institutions in trying to give him the training of an engineer, an effort is made to show that to attain to his highest professional ideal he must first be a man. The spirit of this ideal is best expressed in the words of the late William Starling in his classical definition of a good engineer:

> A good engineer must be of inflexible integrity, sober, truthful, accurate, resolute, discreet, of cool and sound judgment, must have command of his temper, must have courage to resist and repel attempts at intimidation, a firmness that is proof against solicitation, flattery, or improper bias of any kind, must take an interest in his work, must be energetic, quick to decide, prompt to act, must be fair and impartial as a judge on the bench, must have experience in his work and in dealing with men, which implies some maturity of years, must have business habits and knowledge of accounts. Men who combine these qualities are not to be picked up every day. Still they can be found. But they are greatly in demand, and when found, they are worth their price, and their value cannot be estimated by dollars.

*Abstract of presidential address delivered at the annual meeting of the Indiana Engineering Society at Indianapolis, Jan. 15.

†Professor of Civil Engineering, Purdue University, Lafayette, Ind

REPORT OF THE NEW YORK WATER STORAGE COMMISSION.

The New York legislature of 1902 passed an act providing for a commission to investigate floods and their prevention, and appropriated $5,000 for the purpose. The commission was to serve without pay, except necessary expenses, but was to be provided with a paid secretary, and with legal and engineering assistance from the offices of the Attorney-General and the State Engineer, respectively. The two officers named, together with the State Superintendent of Public Works, and the State Commissioner of Forests, Fish, and Game, were made members of the commission. The five citizen members appointed by Governor Odell were as follows: Olin H. Landreth, Schenectady; Elnathan Sweet,* Albany; Geo. W. Rafter, Rochester; John L. King, Syracuse; Geo. R. Finch, Glens Falls.

The commission was appointed in April, 1902, held a number of meetings during the year, and has just reported to the legislature. In brief, it recommends a permanent commission to carry out flood prevention measures through water storage and channel regulation, the cost to be assessed upon those benefited by the improvements. A more extended summary of the results and conclusions of the investigation follows: From data collected by the commission it appears that flood losses in New York State during 1902 were in excess of $3,000,000. This sum does not include loss of life, impairment of health, and the interruption of public travel and private business.

Obviously, flood prevention is but another name for stream regulation, and the benefits resulting therefrom affect (1) the public health, (2) navigation, (3) the reclamation of marsh lands, and (4) the development of water power.

(1) Sanitary conditions would be bettered by flood regulation through more ample and pure water supplies; a decrease of conditions favorable to malaria; a lessening of back-water in sewers, and a more equable dilution of the discharges from sewer outfalls; and by a diminution of the numerous ills peculiar to flooded districts.

(2) Water storage would supply additional feed water for the canals, would increase by over one foot the minimum depth of the upper tidal section of the Hudson, and would diminish the sediment carried by flood currents.

(3) Swamp and inundated lands in New York State aggregate not less than 200,000 acres, including some of the potentially fertilest land in the commonwealth. Much of this land might be reclaimed.

(4) The effect of stream regulation (storage) on water power is illustrated by figures relating to the Genesee, Black, and Upper Hudson rivers. For these three streams, alone, the commission estimates that the additional power to be derived from storage to tide over dry weather would aggregate the equivalent of 3,250,000 tons of coal per year.

Either water storage or channel regulation would have been carried out by groups of individuals long ago were it not for the present law of waters and water courses in this State, which give to every riparian owner, however small and insignificant be his holding, the power to enjoin any change in the natural condition of the stream his holding abuts upon.

In some other States, the right of eminent domain has been conferred by the "mill acts" on those wishing to develop water power. As to land reclamation by drainage, legislation authorizing this already exists, but is not comprehensive enough for large undertakings.

The commission begins its final summary by stating that the continued denudation of forests, with its intensification of freshet conditions, the development of the transmission and use of electric power, sanitary requirements, land drainage, and internal water communication all unite in demanding "an advanced position in this matter of river regulation." The many and various problems involved are beyond individual action or local control. Each stream and its tributaries must be treated as a unit. In view of all these considerations the commission goes on to say:

We believe that State supervision and control is the only safe method of intelligently initiating, constructing and maintaining an adequate system of river improvement in this State. Such State supervision and control, by a commission of recognized competence and character, would not only secure the scientific treatment of each stream as a whole, but the safe and economical execution of the various component parts of a comprehensive system of river improvement in the order of their relative urgency and importance. Legislation providing for such a system of river regulation is in our opinion a great and urgent public necessity.

We believe such legislation should embrace the following essential features:

It should entrust the inauguration and execution of the system to a permanent commission.

The central idea should be that the entire cost of the execution and maintenance of each of the various separate works comprising such a system should be borne by the beneficiaries in proportion to the benefits they respectively derive from it.

The initiative of a work of improvement under this act should be by publication by the commission of a notice of intention to make the improvement or by petition by riparian owners showing facts from which they deem it necessary to regulate the flow of the stream in the interest of the public health or safety, and notice to all interested of time and place to hear objections.

It should be made the duty of such commission to investigate the subject matter presented in such petitions and to approve or disapprove the work they contemplate. If they approve the work, the act should empower and direct them to prepare the necessary maps, plans, specifications and estimates and to execute the work by contract, and stringent regulations and safeguards should be provided in the act for its execution in this matter.

For the acquisition of the necessary property rights the act must obviously confer the right of eminent domain, and it should clearly provide adequate machinery for carrying out condemnation proceedings, reserving the right of appeal conferred by similar statutes of this State.

When the entire cost of any such work of improvement shall have been ascertained, the act should make it the duty of the Water Storage Commission to assess the aggregate cost of each improvement equitably upon all the beneficiaries in proporüon to the benefits accruing to each, and to provide methods of collection conformable to the tax provisions of our statutes.

To insure the progress of such improvements without financial hardship upon the beneficiaries, the act should provide for the issue of bonds limited in amount to the aggregate assessments upon such beneficiaries and secured by such assessments as is done in all important public improvements, and providing in the usual manner for sinking funds and interest charges and the cost of maintenance in determining the yearly taxable assessments.

We are firmly convinced that the prompt inauguration of such a policy by the legislature would more profoundly influence the progress and prosperity of the commonwealth than any public enterprise to which its attention can be directed.

The cost of the system of river improvements provided by such legislation would fall entirely upon the beneficiaries of the several works of improvement, except such expenditures as may be incurred by the commission in the investigation of such of the projects brought before it by petition as it finds it necessary or expedient after careful examination to disapprove, for which expenditure there would be needed a small annual appropriation by the legislature.

*Mr. Sweet died suddenly on Jan. 27. We were indebted to him for a copy of the report of the commission.

ANNUAL MEETING OF THE IOWA ENGINEERING SOCIETY.

The 15th annual meeting of this Society was held in the new Engineering Hall of the Division of Engineering, of the Iowa State College, at Ames, Ia., Jan. 21 to 23. The attendance was the largest in the history of the Society, and the meeting was enthusiastic and successful in every way.

At the opening session on Wednesday afternoon addresses of welcome were delivered by the Mayor, and the officers of the Ames Commercial Club, after which came the address of the President, Mr. M. L. Newton, of Waterloo, and the reports of the Secretary-Treasurer and the Executive Committee.

Road improvement was the opening subject at the evening session on Wednesday, the paper being by Prof. C. F. Curtis, Director of the State Experiment Station. Following this, Prof. G. W. Bissel described the ventilating system in use in the new Engineering Hall.

Two papers on water supply were the feature of the Thursday morning session, papers being presented by Mr. Lancelot W. Andrews, Ph. D., of Iowa City, and Prof. L. H. Pamel, of Ames. The former paper described the water supply and purification system at Budapest.

In the evening a lecture on the Des Moines River Viaduct was given by Mr. H. G. Keith, Bridge Engineer of the Omaha Branch, Chicago & Great Western R. R. Following this came a reception tendered by the Commercial Club and the Faculty of the Iowa State College, which was especially enjoyable because it was the informal opening of the magnificent new Engineering Hall, which is intended to be the Engineers' Club House of the State, as well as a building for instruction purposes for the Iowa State College. The building cost $215,000, is fireproof throughout, and is very finely equipped with furniture and other appointments.

At the Friday morning session a number of papers postponed from the previous days were presented, among them one on "The Ideal Method of Selecting a City Engineer," by Mr. G. W. Miller and Prof. A. Marston.

At the concluding session Friday afternoon the election of officers took place and resulted as follows: President, Prof. S. N. Williams, Mt. Vernon, Iowa; Vice-President, B. Marsh, Des Moines, Iowa; Secretary-Treasurer, W. H. Jackson, Vice-Pres. des Moines Bridge & Iron Works, Des Moines, Iowa; Directors, Prof. A. V. Sims, Iowa City, Iowa; and C. R. Allen, Ottumwa, Iowa.

Additional interest was given to the meeting by the fact that the evening sessions were held jointly with the Iowa Brick and Tile Manufacturers' Association, which held its annual meeting at the same time and place.

WORK TRAIN RECORDS ON THE RIO GRANDE, SIERRA MADRE AND PACIFIC RY.*

By L. P. Atwood.†

In view of the general interest in records of railway work and of cost of work, I submit a copy of my report to Mr. John B. Ramsey, General Manager, covering some embankment repairs made in the fall of 1902. The following statements will suffice to explain the report:

1. All prices are in Mexican silver dollars, worth 40 cts.
2. Laborers are very scarce.
3. Coal costs $11.25 per ton of 2,000 lbs.
4. Men worked from daylight to dark.
5. Flat cars 30 and 34 ft. long are taken to hold 8 and 10 cu. yds. respectively when loaded with all they will carry. This is the result of previous experience.
6. The dirt after being unloaded is left for section gangs to spread and dress, which is a small item in this work.
7. The method of loading and unloading with the same gang was followed because of the scarcity of labor and of cars.

In tie-renewals, since July 1, 1902, I have been marking all new ties with dating nails.

WORK TRAIN RECORD: SEPT. 11 TO NOV. 3, 1902.

Yardage Distributed.

Kilo. 127	318 cu. yds.	Kilo. 139	4,530 cu. yds.
" 128	1,356 "	" 140	2,244 "
" 135	86 "	" 141	1,500 "
" 136	332 "	" 142	1,202 "
" 137	640 "	" 143	1,272 "
" 138	770 "	Siding	1,722 "

Total yardage.....15,972 cu. yds.
Average haul.....16.2 (kilos).

Cost.

Pay rolls	$2,533.90
Train service (labor)	509.80
Engine service (labor)	678.13
Coal, oil, etc	2,061.99
Tools, use of	22.67
Total	$5,806.67
Cost per cu. yd., cts	36.36

Percentages.

	Per cent.
Foremen, rustling men and clerical	10.50
Labor	33.10
Train service	8.75
Engine service	11.65
Coal, oil, etc	35.45
Tools, use of	.55
Total	100.00

Days Worked.

Train	50
Foreman at $4	67*
Foreman, $2	50
Foreman, $1.50	50
Rustle men, $2	50
Laborers, $1.25	1,537½
Water boy, 75 cts	50
Clerk, $30	

*Waiting for tools. Custom house delay.

Miscellaneous.

Loading	1 pick to 2 shovels.
Unloading	All men.
Laying and moving pit track	33 days' labor.
Average number of cars per train	16.

*Abstract of a paper read at the annual meeting of the Illinois Society of Engineers and Surveyors, at Aurora, Ill., Jan. 21 to 23.

†Engineer of Maintenance of Way; Rio Grande, Sierra Madre & Pacific Ry., El Paso, Tex.

ANNUAL MEETING OF THE AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

The ninth annual meeting of this society was held at 12 West 31st St., New York city, on January 20, 21 and 22. It was the largest meeting that has ever been held by the society, about 80 members and guests being in attendance. The membership list of the society now numbers 174, having increased considerably during the year, and the finances are in good condition, there being a sufficient surplus to insure the prompt publication of the annual volume of proceedings, and also to "provide for an appropriation" of $200 for the work of the committee on tests.

The first session was held on Tuesday evening, January 20. The retiring president, Mr. A. E. Kenrick, made an address, which was followed by reading of the annual reports of officers and standing committees and other general business. Prof. J. H. Kinealy then read a paper on Temperature Regulation, which was discussed by several members. Other sessions for the reading and discussion of papers and topics were held on Wednesday afternoon and on Thursday morning and afternoon. On Wednesday evening a subscription dinner was held at the New Brunswick Hotel, which was attended by about 70 members.

The following officers of the society for the ensuing year were elected by letter ballot: President, H. D. Crane, Cincinnati, O.; 1st Vice-President, William Kent; 2d Vice-President, Reginald P. Bolton; Secretary, Wm. Mackay; Treasurer, J. A. Goodrich, all of New York city. Board of Governors: A. E. Kenrick, Brookline, Mass.; R. C. Carpenter, Ithaca, N. Y.; John Gormly, Philadelphia; C. B. J. Snyder, New York; George Mehring, Chicago.

Brief notes of the papers read at the meeting follow:

TEMPERATURE REGULATION, by J. H. Kinealy.—The author classifies temperature regulation under the heads of hand and automatic, each of which is subdivided into group and individual regulation. He discusses different varieties of each, and the reasons why no automatic system has yet come into general use.

A consideration of the different methods of regulating the temperature of rooms heated by direct radiation steam systems, leads to the conclusion that they may be classed under four heads as follows:

1. Varying the pressure in the supply pipe and correspondingly varying the pressure in the radiators.
2. Maintaining a fixed pressure in the supply pipe and alternately connecting and disconnecting each radiator by opening and closing a valve.
3. Maintaining a fixed pressure in the supply pipe and increasing or decreasing the amount of radiating surface of each radiator according to the demands.
4. Maintaining a fixed pressure in the supply pipe and a lower pressure in the return pipe with an intermediate pressure in each radiator, controlled by some throttling device between the supply pipe and the radiator.

The public generally demands that schools at least shall be provided with an adequate system of temperature regulation, and by demanding further that this regulation shall be independent of the teachers; that it shall be automatic. The public has not yet gotten to the point where it demands that the rooms of office buildings and other buildings in which men spend a large portion of their lives shall be subject to temperature regulation, but the fact that here and there automatic temperature regulation is installed in various buildings shows that there is a demand which is slight, which is growing, but which is not so great as to induce owners of buildings to spend the money necessary to install automatic regulation. If some method of hand regulation other than the crude one of turning on or shutting off the radiator could be made fairly successful, there would be at once a ready market for it, because of the need which now exists for temperature regulation. And the public having once enjoyed the comforts of a fairly successful method of hand regulation would demand more and more that systems of automatic regulation be installed in connection with heating systems.

FURNACE HEATING AND VENTILATING SYSTEM IN THE PUBLIC LIBRARY AT ILION, N. Y., by W. H. Switzer.—This paper contains an illustration and detailed description of a heating and ventilating apparatus which has proved completely successful for ten successive winters. There are two furnaces and two fireplaces (which are never used) with vent flues for the outlet of foul air. Anemometer tests have been made showing the speed of the air currents and the proportions of heating and grate surface, area of flues, registers, etc., are given, together with particulars relating to the building, the coal consumption, etc. This paper should be a useful one for study by designers of furnace heating systems.

TEST OF A HOT-AIR GRAVITY SYSTEM OF HEATING AND VENTILATING IN A SCHOOL BUILDING, by B. H. Carpenter.—This paper illustrates and describes the heating system of an eight-room school house, and gives the record of two complete all-day tests made in December, 1902. The plant was designed to deliver 1,500 cu. ft. of air per minute into each room. The actual delivery in different rooms and at different hours in the day ranged from 1,100 to 2,100 cu. ft. per minute. The outdoor temperature ranged from 24° to 40°. In the discussion it was stated that the ventilation would probably prove defective on warmer days, and that the results of the tests confirmed the general belief that the gravity system ought not to be used in a school house.

THE SMOKE AND GAS FLUE SYSTEM IN THE ANSONIA APARTMENT HOUSE, by R. P. Bolton.—This paper describes something new in the chimney flues of fireplaces in apartment houses, being the installation of exhaust fans on top of the building to produce an induced draft in the flues. The building contains 340 suites of apartments and more than 2,000 rooms, with 63 fireplaces on each floor, or 1,133 in all.

COOLING AN AUDITORIUM BY MEANS OF ICE, by John J. Harris.—This paper contains an illustrated description of a temporary apparatus used successfully to cool an auditorium of a seating capacity of 900 when 1,400 persons were packed in it, on the occasion of a high-school commencement. It consisted of a fan of a capacity of 3,000,000 cu. ft. of air per hour blowing air over a stack of shelves on which ice was piled. The ice melted during an evening was 13,000 lbs. The outside temperature was 90°, while the inside was maintained at 76°. The moisture was controlled and kept at a normal degree by the use of chloride of calcium in shallow pans placed in the air ducts.

THE CAPACITY OF CAST-IRON SECTIONAL STEAM BOILERS, by J. J. Blackmore.—This paper is a complaint of the absence of any rule for rating the capacity of cast-iron sectional boilers used for heating, or of any convenient way of approximating the measurement of their heating surface. The author gives the following approximate formula for the push nipple type of boiler:

$$X = \frac{(W + D) \times 2\ H}{144}$$

in which X is the heating surface in square feet, W the width across the flues at the waterline of the heater, in inches; D the depth of the section in inches, and H the height in inches from the grate line to the top of the section. An addition of 10% is made in the case of the header type of boiler. He rates the horse-power of the boilers as in power practice, 10 sq. ft. per HP. for water-tube and 12½ sq. ft. for fire-tube boilers: 1 HP. = 33,316 B. T. U. per hour, 1 sq. ft. radiation surface giving off 275 B. T. U. per hour, 1 HP. = 122 sq. ft. of radiation surface, or 1 sq. ft. of boiler surface to 10 sq. ft. of radiation on an average ranging from 1 to 8 to 1 to 12 under different conditions.

NEW SHOPS AND EXTENSIONS OF ITS LINES are to be built by the Chicago & Eastern Illinois R. R., which now forms a part of the St. Louis & San Francisco Ry. system. An extension will be built from Sullivan to St. Louis, and Mr. T. L. Condron, of Chicago, has been appointed Consulting Engineer for the bridge work, his duties including the preparation of shop plans, as well as general designs. Most of the bridge work will be of plate girder construction, designed for the class E-50 loading of Cooper's specifications. The contract has been let to the American Bridge Co., which has assigned the manufacture to its Detroit shops. Delivery is to be commenced in June and completed by December. The new shops at Danville, Ill., will be of steel frame construction, and will include a machine shop, 308 × 120 ft., with an 80-ton crane of 75 ft. span; boiler shop, 105 × 200 ft., with a 25-ton crane of 55 ft. span, and a blacksmith shop, 100 × 140 ft. The machine shop is now under erection. There will also be a power house. Mr. W. E. Walker, of Chicago, is architect for the buildings, and Mr. T. L. Condron is Consulting Engineer for the structural work, the contract for which work has been let to the Structural Department of the Illinois Steel Co., Chicago. The mechanical and electrical equipment will be designed by the Arnold Electric Power Station Co., also of Chicago. Mr. W. S. Dawley is Chief Engineer, and Mr. T. A. Lawes is Superintendent of Motive Power.

A TEN-COUPLED TANK LOCOMOTIVE for suburban service, designed for rapid acceleration and ready handling of heavy trains making frequent stops, has been built at the shops of the Great Eastern Ry., of England, to the designs of Mr. James Holden, Locomotive Superintendent. The acceleration is said to be 30 miles per hour in 30 seconds, but the weight of train thus accelerated is not given. The engine has ten wheels, all coupled, the middle (main) drivers having blind tires. Owing to the height of the engine, the smokestack is little more than a molding upon the top of the smokebox. The engine has three cylinders, but is not worked compound. The principal dimensions are as follows:

Driving wheels	4 ft. 6 ins.
Wheelbase	19 " 8 "
Length over buffers	37 " 9 "
Weight in working order	60 gross tons.
Cylinders (three)	18½ × 24 ins.
Boiler, diameter inside	5 ft. 3 ins.
Boiler, height from rail to center	9 "
Firebox, length inside	6 "
Steam pressure	200 lbs.
Tubes (steel), 395, diameter	1¾ ins.
Tubes, length	16 ft.
Heating surface, total	3,010 sq. ft.
Grate area	42 " "
Water in tanks	8,400 U. S. gallons.
Coal in bunker	3½ gross tons.

AN AUSTRALIAN TRANSCONTINENTAL RAILWAY through the colony of South Australia, connecting Adelaide on the south with Port Darwin on the north, is now being promoted under an act passed by the South Australian parliament last year. Both terminals already have railways forming a part of the route, but the new construction would be a line 1,063 miles in length from the Oodnadatta to Pine Creek. It will be of 3 ft. 6 ins. gage, and laid with rails weighing not less than 60 lbs. per yd. Specifications and forms of proposal have been filed at the office of the Agent-General for South Australia in London, and proposals will be received until April, 1904. The contract may be let for the whole work or for certain portions, and the contractor must build at least 200 miles within the first two years and 100 miles each year thereafter, the whole road to be completed in eight years. Much of the line passes through a desert, which has rarely been crossed, but over which a telegraph line was built some years ago. Payment will be made partly on the land grant system, and proposals must state the quantity of land demanded for the construction of each mile of line, which is not to exceed 75,000 acres. No definite location surveys have been made, but reports and preliminary plans will be furnished to persons proposing to bid for the work. An east and west Australian transcontinental railway was noted in our issue of Jan. 23, 1902.

STEAM MOTOR CARS using petroleum fuel are to be tried on the French railway from Paris to Dijon, according to a recent report in the London "Times." Three of these cars are now being built to be run together as a fast train, and a speed of 62 miles per hour is aimed at. Each car is 56 ft. long over all and weighs about the same as a first-class corridor carriage. The machinery occupies a space of 8½ ft. at the front of the carriage. The expected fuel consumption of the motor is stated as about 3½ lbs. of oil per car mile. Two motor cars of a different type, according to the same authority, are being built at the York shops of the Northeastern Ry. of England. These cars carry an 85-HP. oil engine of the 4-cylinder type driving a dynamo which supplies current to the motors connected to the car axles. These cars are to be tried in local traffic where frequent stops are required.

A NEW OUTFALL SEWER AT LOS ANGELES, CAL., will be built soon, $670,000 of bonds having been voted for the purpose. A portion of the new outfall is designed to serve the same purpose as a septic tank, and it is also proposed to use at least some of the sewage for irrigation, apparently after the septic effluent has passed through filter beds. In addition to bonds for the new outfall sewer, $330,000 have been voted for extending main lateral sewers, and $400,000 for storm sewers. The latter will discharge directly into the Los Angeles River, the bed of which is dry nearly the whole year through. The preliminary surveys for the work mentioned have been made and it is expected that location will be started at once, and that some contracts will be advertised in three or four months. Mr. Harry F. Stafford is City Engineer of Los Angeles, and we are indebted to him for the particulars given. The old outfall sewer was described at length in Engineering News for Feb. 28, 1895, and in our issue of Feb. 10, 1898, there appeared a short article on its operation. It has a total length of 12.4 miles, about half of which is 38-in. wood stave pipe, laid as two inverted siphons, and the balance is of brick, mostly 40 ins. in diameter, finished inside with ½-in. of neat cement plaster. In our issue of June 22, 1899, we noted briefly that the cement plastering and the 2 to 1 cement mortar in which the brick were laid were rapidly disintegrating, and that the ironwork of the manholes and chambers were corroding. A detailed report on an investigation of the nature and extent of the disintegration of the cement work, and also an account of experiments on the use of the outfall sewer as a septic tank was published in our issue of Nov. 8, 1900. It appears from the letter written to this journal by Mr. Stafford that the wood stave pipe is now giving trouble through the failure of the bands, sometimes necessitating shutting off the flow of sewage and pumping out the contents of the siphon in order to make repairs. The old outfall is not so located as to drain annexed portions of the city, and rather than overhaul the old outfall and build a new one for the annexed district it has been decided to build a single new outfall for the entire city.

POTASSIUM CYANIDE is said to have been electrically made by Prof. Edward O'Neill, of Berkeley, California. A hydrocarbon vapor, nitrogen from the air, and an electric arc are said to be the agents in making HCN, which is then combined with potash producing KCN, or potassium cyanide. Whether the process will be commercially successful remains to be seen.

A NEW DRAINAGE TUNNEL on the Comstock lode has been started by the Gold Canon Extension Tunnel Co. The tunnel will be an extension of the Sutro, extending from the Alta to the Dayton shaft, a distance of 8,300 ft. Franklin Leonard, Jr., of New York, is said to have been the prime mover in this projected tunnel work.